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# MANUFACTURE OF DIMENSION STOCK FROM NORTHERN HARDWOODS

By

A. O. BENSON

Wood Technologist, Forest Products Laboratory
Branch of Research, Forest Service

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By A. O. Benson,[1] *Wood Technologist, Forest Products Laboratory,*[2] *Branch of Research, Forest Service*

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[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

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## INTRODUCTION

The process of lumber manufacture is a process of selection—selection of stands of timber for the species that the markets demand, selection of stands that can be logged advantageously, selection from such stands of the trees that can be converted into logs with costs that are not excessive, selection of logs that will pay the costs of their conversion into lumber, and selection of boards that will meet the demands of the trade. Directly and unavoidably as a result of such selection there occurs a large amount of waste—waste stands, waste trees, waste logs, waste lumber, and the slabs, edgings, and trimmings necessarily incidental to the conversion of logs into well-manufactured square-edged lumber.

The term "waste" as used here refers to material that because of its size, form, or quality is unsuitable for use for the primary product for which any specific operation may be conducted. Since lumber forms the primary product of the sawmill the unutilized material left in the woods for one reason or another, together with the portions of the log that are cut away in the mill in making marketable lumber, are classed as waste.

Investigations by the Forest Service [3] have shown that small trees and logs in the hardwoods of the Lake States can not under present common methods be cut profitably into standard grades of long, wide lumber. Naturally the minimum profitable sizes depend on many factors, such as species, accessibility, manufacturing facilities, and market value for products. Hence, not only do profitable diameter cutting limits for standard lumber vary as between different operations, but from time to time for the same operation.

Even under cutting practice regulated by actual cost figures indicating that small trees will not pay their way for lumber, some small logs are unavoidably cut incidental to large ones. Small diameter and short logs occur in tops and in large limbs. There are occasional logs of large diameter, 4 to 6 feet long, that can not be handled profitably for the lumber they may yield. Logging roads, skidways, and landings require the cutting of small trees as well as large. For the purpose of forest sanitation small trees damaged in the falling of larger ones, together with those partly defective or poorly formed, should be cut in preference to leaving them to deteriorate or occupy the stand. Paper birch and aspen, which occur in mixture with softwoods and other northern hardwoods, customarily have been left standing because they do not fit in with the scheme of logging, milling, and marketing that operates successfully with the species among which they grow. (Fig. 1.) These two species are short-lived and if mature will not endure another long rotation. They therefore constitute another source of small logs. Thus many areas in the hardwoods of the Lake States that have been logged over for lumber exhibit much raw material that might be utilized for products other than lumber.

## PURPOSE

The purpose of this circular is to provide information on the manufacture of dimension stock from material now unutilized in

[3] ZON, R., and GARVER, R. D. SELECTIVE LOGGING IN THE NORTHERN HARDWOODS OF THE LAKE STATES. U. S. Dept. Agr. Tech. Bul. 164, 47 p., illus. 1930.

lumber production so that the hardwoods of the Lake States can be made to yield a more profitable return. Viewed broadly, the growing of timber on a sustained-yield basis and a more extensive utilization of the crop by the manufacture of dimension stock, pulpwood, and other products from material unprofitable for lumber should greatly assist in stabilizing and perpetuating the manufacture of forest products in the Lake States as well as in other regions. Although the emphasis in this circular is placed on dimension stock from waste material and as a by-product of lumber operations it should be recognized that the possibilities are by no means limited to waste. Dimension stock as a primary product from good logs warrants equal consideration. The results presented here are based upon studies made at typical lumber plants manufacturing dimension

FIGURE 1,—Paper birch, which customarily has been left standing in the Lake States, provides a good source of small logs for dimension stock

stock and represent the best current methods of operation and cost accounting.

## DEFINITION OF DIMENSION STOCK

There is a general understanding among timber owners and lumbermen of the term "dimension stock," but there is difference of opinion with respect to the limits of application of the term. Dimension stock in a restricted sense may be defined as squares or flat stock usually in pieces under the minimum sizes admitted in standard lumber grades, rough or dressed, green or dry, cut to the approximate dimensions required for the various products of woodworking factories. It may be used in the manufacture of a wide variety of products, such as furniture, automobile bodies, turnings, and caskets.

Dimension stock should be distinguished from "ready-cut stock," which is defined as material green or dry, sawed, turned, shaped, or otherwise machined to the exact condition and dimensions required for assembly into the various products of wood-using factories.

## DIMENSION-STOCK MANUFACTURING METHODS

There are four steps in the conversion of a log into the finished article made from dimension stock. The four steps required for

the transformation occur in the following sequence: (1) Sawmill manufacture; (2) seasoning; (3) working to size; and (4) assembly. Only the first two steps, in which the material retains the name dimension stock, are dealt with in this circular. During the third step the material loses its identity as dimension stock and becomes ready-cut stock. After step four, which is the assembly into the finished product, the material acquires the name of the finished article; that is, a chair, a table, an automobile body, and the like.

About 85 per cent of all hardwood lumber is cut into smaller sizes before it is in the form required for assembly. Hence, the potential market for dimension stock is practically as great as for long, wide lumber. In fact, the cost figures obtained in this circular, together with the consideration of saving in freight, lower overhead and labor rates, and the ability to utilize a lower grade of raw material suggest that more attention might be given to the possibility of transferring to the sawmill a number of the machining operations that are now carried on at the factory.

Low-grade or waste material as a source for dimension stock in the Lake States hardwood region occurs chiefly in three forms: (1) Dimension stock from small logs, namely, 11 inches and under in diameter and 8 feet and over in length; (2) dimension stock from short bolts, namely, logs under 8 feet in length; and (3) dimension stock from mill waste. So varied are the methods of manufacture of each type that each operation presents something different from all others. Methods have therefore been studied with the object of obtaining from a number of typical operations those practices that are outstandingly meritorious.

The methods dealt with are confined principally to the foregoing three forms of waste. The results have been obtained mainly in northern sawmills of the large or permanent type. This circular is therefore not intended to cover all the important methods of dimension-stock manufacture, certain of which have been dealt with in some detail in other publications.[4] [5]

With proper organization the manufacture of dimension stock from the side lumber that is obtained when logs are sawed into ties offers excellent opportunities for putting to good use a by-product that often must be disposed of as waste or at little better than waste prices. Slow-moving stocks of low-grade lumber under certain conditions can be cut up into dimension stock with promise of better returns than are otherwise possible. Veneer cores generally are not of much value as a source for high-grade dimension stock. However, cores may yield sound cuttings suitable for parts of products where appearance is not a prime essential and also for boxing and crating strips. Other forms of raw material from which dimension stock may be produced are edgings from kiln-dried flooring strips, trimmings developed in the remanufacture of lumber, and trimmings from veneer bolts.

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[4] United States Department of Commerce, national committee on wood utilization. small dimension stock—its seasoning, handling, and manufacture. 84 p., illus. 1929.

[5] Hoyle, R. J. the manufacture and use of small dimension. N. Y. State Col. Forestry, Syracuse Univ., Tech. Pub. 20, 94 p., illus. 1927.

## DIMENSION STOCK FROM SMALL LOGS

The term "small log" is general. In order to be specific the product contemplated from the small log must be recognized. A log too small to pay its way when cut into lumber is one thing, one too small to pay its way when cut into ties, another, and one too small to pay its way when cut into dimension stock, still another. The term "small log" as used in this circular refers only to logs too small in diameter or length or both to be profitable for lumber under present methods of manufacture.

### TYPES OF MILLS PRODUCING DIMENSION STOCK FROM SMALL LOGS

Dimension stock is produced from small logs either in sawmills that are operated as independent units or in departments operated as auxiliary to large sawmills whose primary product is lumber. Each method has its advantages and disadvantages. The independent unit has the advantage of being able to focus its attention on a single class of product, whereas the large sawmill specializes on lumber and treats dimension stock as a side line. However, for plants of equivalent capacities the independent unit has higher indirect costs than the auxiliary. The auxiliary has comparatively small costs for housing, supervision, power, and other items of expense that can be shared with the lumber department of the sawmill.

### GOOD EQUIPMENT A PRIME REQUISITE

Efficient equipment is one of the chief factors that determine successful and economical operation of dimension-stock mills. This does not imply that equipment must be new, costly, or complicated, but it must be designed with a view to minimizing labor, material, and maintenance costs, and it must be capable of precise work.

A mill must be so well constructed and equipped that the chances for shutdowns for repairs are reduced to the minimum. A prospective buyer first of all must have definite assurance that a mill that undertakes to supply him with dimension stock will not fail to make deliveries at specified times. Present-day factory practice tends more and more toward a system whereby incoming raw material keeps pace with current production needs, the minimum of surplus stock being held in reserve. The dimension-stock mill, in order to meet this situation, must be prepared to maintain continuous production.

The choice of equipment for cutting dimension stock from small logs calls for a thorough study of each specific operation. There are local conditions that make one type of machine suitable for one operation but impractical for another. The kind of power available, size of logs, species of wood, nature of product, precision required, and other considerations should all contribute to the decision as to the advantages or disadvantages of one or another machine or manufacturing device.

The following general discussion of equipment suitable for the manufacture of dimension stock from small logs applies only to mills that are operated as independent units. A discussion of equipment

for sawmills operated as auxiliary departments to large sawmills whose primary product is lumber is given on pages 31 to 39.

## GENERAL LAYOUT FOR A DIMENSION-STOCK MILL THAT IS OPERATED AS AN INDEPENDENT UNIT

A steady production of 5,000 board feet of dimension stock per 10-hour shift is a fair output. Hence, suggestions for buildings, equipment, and labor are based on the needs of a mill of 5,000 board feet capacity. Figure 2 presents a layout for a dimension stock mill that is operated as an independent unit. The building, 40 feet wide by 80 feet long, is designed to furnish sufficient space for manufacturing equipment, for storage of stock in process of manufacture, for a filing and work shop, and for a small office. It does not provide space for equipment required to produce stock in form beyond the rough square-edged stage. With a crew of not to exceed eight men, shifting from operation to operation as required, this mill constitutes an economical unit.

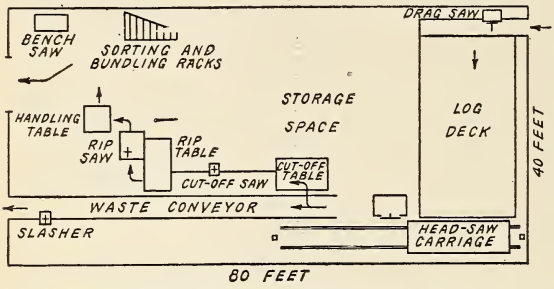


FIGURE 2.—A layout for an independently operated mill cutting dimension stock from small logs

Studies show that the total cost of a mill of this type, together with equipment and drying sheds, is about $12,000 at 1930 prices. The mills studied were not provided with buildings of a very permanent type nor with the best of new up-to-date equipment. Dry-kiln installation would add another considerable item of expense not included in the above estimate.

A dimension-stock mill operated in conjunction with a sawmill, needs no separate log pond. For an independent unit a log pond is desirable. For summer operation a pond serves to prevent end checking of logs and aids in the elimination of any gravel that may have become imbedded in the bark. For winter operation, however, a pond introduces some difficulties at mills using purchased electric power since such mills have no steam available with which to keep the pond open.

## POWER

If service rates are reasonable, electric power may be preferable to steam power developed at the mill. Electric power eliminates the cost of boiler and engine equipment, the expense of an engineer and watchman, and considerable upkeep expenses. Studies at one mill located in the Lake States and of the size given in Figure 2 show that the cost of a night watchman tending a boiler would practically equal the entire cost of electric power for the mill.

All the machines in a dimension-stock mill using electric power should have individual motor drives. Such arrangement is not only economical from the standpoint of power, but a breakdown of one piece of equipment does not incapacitate other machines.

In most communities of appreciable size there is a fair and profitable outlet for fuel wood. With electric power available the sale of fuel may almost offset the cost of power, whereas with steam power the greater portion of the mill waste is required for boiler fuel.

Where it is necessary to develop steam for continuous dry-kiln operation it is often more economical to use steam power for the mill than to purchase electric power developed by a public-utility agency.

The use of electric power necessitates supplying heat to the mill in winter. Usually in a steam-driven mill of weather-tight construction, the steam pipes, together with a few extra coils, keep the mill fairly comfortable in cold weather and also reduce the formation of frost on the ceiling; hence the reduction of subsequent drip-

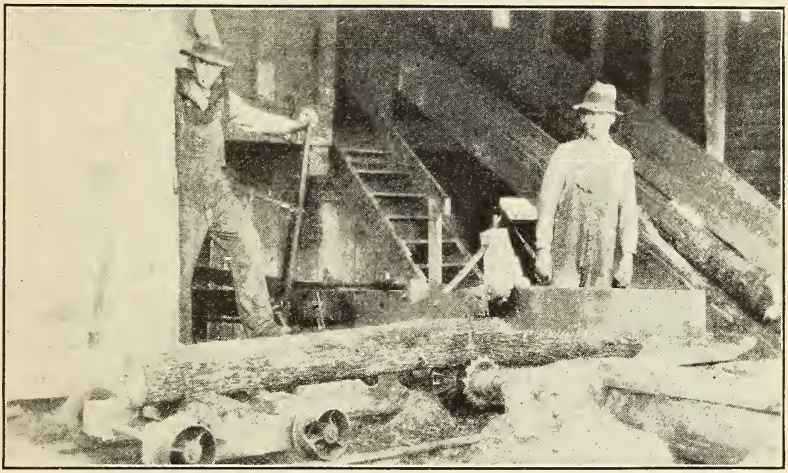

FIGURE 3.—A typical drag-saw installation in a dimension stock mill in the Lake States

ping of moisture during periods of thaw. One practical solution for the small electrically driven mill is the installation of wood-burning stoves.

## CROSSCUTTING LOGS

Crooked long logs, if crosscut at the proper places, will often yield straight short logs that are suitable for dimension stock. Crooked logs, however, cause much loss of material when cut by a head saw, and in addition the labor cost on such logs is high because of the time lost in getting them properly placed and "dogged." A saw, either circular or drag, should therefore be installed on the log deck for crosscutting crooked logs. A circular saw cuts faster than a drag saw, but it needs constant attention while operating. A drag saw, on the other hand, will cut logs of any size and needs little attention except when changing from one cut to another. (Fig. 3.) In so far as possible the division of logs is governed by the lengths of dimension stock to be cut, an effort being made to obtain straight sections of the maximum length.

## HEAD SAWING

There are a number of head saws on the market that are designed for sawing small and short logs. Hand-operated head-saw carriages have given way to power-driven types. For small carriages the friction feed is used more generally than other forms of drive. The piston steam feed is not practical where there is no high-pressure steam available. A power-driven carriage may be arranged for both the setting and the "dogging" to be done by the sawyer, or it may be of the type that calls for an extra man to operate the dogs while the sawyer does his own setting, or the extra man may do both setting and "dogging." Since the head sawyer is a relatively high-paid man it is usually desirable to speed the operation through the use of an extra man on the carriage.

Most of the head saws in small mills are circular saws since the size, weight, and cost of a substantial band head saw is out of proportion with the scale of ordinary small-mill construction, and for equivalent sawing rates, the power consumption for circular saws is less and installation and adjustment are simpler than for band saws. Moreover, fitting, especially with saws of the inserted-tooth type, can be accomplished by a filer or mechanic of ordinary ability; in fact, the sawyers usually keep such saws in shape. All the bits on inserted-tooth saws can be sharpened in about five minutes. A good filer at wages of from $6 to $7 per day is required to keep a solid-tooth saw in first-class shape, although the actual time filing will not keep him employed 20 per cent of the time. In their usual condition, the solid-tooth saw will not cut so much nor so true a cut as the inserted-tooth saw. The initial cost of a solid-tooth saw is about one-third less than that of an inserted-tooth saw. As far as actual sawing is concerned, the solid-tooth saw, when in good shape, will cut a trifle cheaper per thousand board foot than the inserted-tooth saw. Bits for an inserted-tooth saw cost at the rate of about 2½ cents per thousand feet, board measure, and shanks and files cost about 4 cents per thousand board feet. However, for the small mill the net advantage is strongly in favor of the inserted-tooth saw. The head saw should be capable of cutting logs up to 20 inches in diameter. The diameter of the head saw should therefore be not less than 48 inches, and about 25 horsepower should be available for operating the saw.

Band saws cut a kerf of about three thirty-seconds inch. Circular saws cut a kerf from three-sixteenths to three-eighths inch. Thus the circular saw causes a waste in kerf of at least twice that resulting with the band saw. Since the major portion of the delivered cost of small logs consists of labor charges, the reduction in saw kerf is an important item, even where stumpage rates are nominal.

Some types of head-saw carriages are designed especially to handle bolts about 4 feet long. Such equipment is unsatisfactory for general dimension-stock manufacture since there is demand for dimension stock over 4 feet in length. Short-log carriages that will handle logs up to 10 feet long should therefore be used.

The sawing methods used at the head saw vary with species, size of logs, size of stock to be cut, type of equipment, and judgment of sawyers. For certain products it may be especially desirable to get

the maximum of sapwood of the log apart from the heartwood, and to do this the customary method of "boxing the heart" is employed. With such a wood as basswood, where there is no marked distinction between sapwood and heartwood, there is no particular object in the heart-boxing method except as a means of eliminating the defects that are often associated with heartwood.

Figure 4 indicates a method followed in head-sawing hard maple logs 8 to 10 inches in diameter, where efforts are made to develop the maximum volume of large sapwood squares. One-inch squares with this method are not cut intentionally. However, some 1-inch squares are certain to develop when edging, ripping, and trimming out defects from the 1½ and 2 inch flitches. Even with the most skillful sawing, it will occasionally be necessary to cut 1-inch flitches to get the maximum yield from a log.

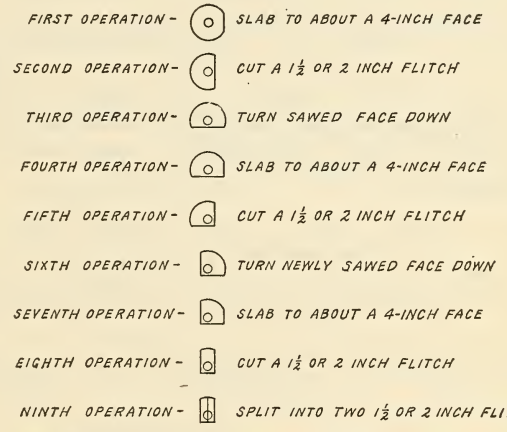
FIRST OPERATION - SLAB TO ABOUT A 4-INCH FACE
SECOND OPERATION - CUT A 1½ OR 2 INCH FLITCH
THIRD OPERATION - TURN SAWED FACE DOWN
FOURTH OPERATION - SLAB TO ABOUT A 4-INCH FACE
FIFTH OPERATION - CUT A 1½ OR 2 INCH FLITCH
SIXTH OPERATION - TURN NEWLY SAWED FACE DOWN
SEVENTH OPERATION - SLAB TO ABOUT A 4-INCH FACE
EIGHTH OPERATION - CUT A 1½ OR 2 INCH FLITCH
NINTH OPERATION - SPLIT INTO TWO 1½ OR 2 INCH FLITCHES

FIGURE 4.—A method followed in head sawing hard maple logs of 8 to 10 inches diameter, where efforts are made to develop the maximum volume of large sapwood squares

The method of sawing logs through and through into flitches is commonly used when logs are of good quality and when there is no call for the separation of the sapwood from the heartwood. Even in birch and maple, where the sapwood and heartwood are quite distinct, the method of sawing into flitches is followed in good logs having only a small volume of heartwood. Sawing logs through and through, or "alive," is more rapid than turning the log down, because of the fewer setting and "dogging" manipulations.

Precision in manufacture starts at the head saw. The first precautions are proper setting for thickness and adjustments that will prevent abnormal variations under or over the thickness set. A proper allowance for shrinkage of the wood is of major importance. Shrinkage varies not only with species but also within each species depending upon whether the log is cut so as to yield flat-grained or quarter-grained boards, or boards that vary between flat and quarter grain. To make allowance for all the factors that cause variation in amount of shrinkage is impractical. About the best that can be done is to make sufficient allowance to take care of the maximum shrinkage that may be expected.

In cutting dimension squares the mistake is often made of allowing the same margin for shrinkage regardless of the size of the squares. In other words, if 1/16-inch oversize is allowed on a 1-inch square the same allowance is often erroneously made on larger squares, thus disregarding the fact that the larger the square the greater the shrinkage. If a piece 1 inch in width shrinks one-

sixteenth inch, a piece 3 inches in width will probably not shrink quite three times as much but approximately that amount.

Throughout this circular all measurements of dimension stock unless otherwise stated are based on the air-dry sizes, that is, allowance has been made for shrinkage.

Table 1 has been prepared for use as a rough guide to sawing sizes. It is based on measurements of dimension stock made just after it was cut from hard maple logs in a green condition and also after it was kiln dried to a moisture content of 7 per cent. It is pointed out that the allowances for shrinkage in Table 1, while only approximately correct, are nevertheless within the setting limits of sawmill machinery. Flat-sawed hard maple shrinks about 9 per cent in width when drying from a green condition to a thoroughly oven-dry condition. Other woods which shrink about the same amount in width are basswood, paper birch, yellow birch, soft elm, and white oak. Aspen, white and black ash, rock elm, soft maple, and red oak shrink slightly less in width than sugar maple, and beech shrinks slightly more. When woods are quarter-sawed they shrink only from one-third to three-fourths as much in width as when flat sawed. Shrinkage in length is so slight that it may be ignored.

TABLE 1.—*Sawing sizes for green dimension stock and corresponding sizes when dried to 7 per cent moisture content*

[Based on actual measurements of shrinkage of hard maple dimension stock from a green condition to a kiln-dried condition of 7 per cent moisture content]

| Required green cutting size,[1] inches | Rough size at 7 per cent moisture content, inches | Required green cutting size,[1] inches | Rough size at 7 per cent moisture content, inches |
|---|---|---|---|
| 1 1/16 by 1 1/16 | 1 by 1. | 1 1/32 by 5 13/32 | 1 1/4 by 5. |
| 1 1/16 by 2 5/32 | 1 by 2. | 1 1/32 by 6 15/32 | 1 1/4 by 6. |
| 1 1/16 by 3 1/4 | 1 by 3. | 1 5/8 by 1 5/8 | 1 1/2 by 1 1/2. |
| 1 1/16 by 4 5/16 | 1 by 4. | 1 5/8 by 2 5/32 | 1 1/2 by 2. |
| 1 1/16 by 5 13/32 | 1 by 5. | 1 5/8 by 4 5/16 | 1 1/2 by 4. |
| 1 1/16 by 6 15/32 | 1 by 6. | 1 5/8 by 6 15/32 | 1 1/2 by 6. |
| 1 1/32 by 1 1/32 | 1 1/4 by 1 1/4. | 2 5/32 by 2 5/32 | 2 by 2. |
| 1 1/32 by 2 5/32 | 1 1/4 by 2. | 2 5/32 by 4 5/16 | 2 by 4. |
| 1 1/32 by 3 1/4 | 1 1/4 by 3. | 2 5/32 by 6 15/32 | 2 by 6 |
| 1 1/32 by 4 5/16 | 1 1/4 by 4. | | |

[1] Additional size must be provided to allow for variation in sawing, warping, twisting, and the like.

Though occasional pieces may shrink more or less than the amounts indicated, in general, Table 1 will serve as a safe guide for sawing dimension stock into either flat or quarter-grained material. No allowance, however, is made in Table 1 for variation in sawing nor for warping that may occur during drying, since these factors are largely under the control of the operator. Greater errors in the manufacture of dimension stock from small logs frequently occur from poorly fitted saws, misalignment, and other misadjustments, than from disregard of the shrinkage factor. Among other things, the amount of warping, diamonding, or the like, taking place in drying depends upon the kind of wood, size of pieces, and method of drying. Hence, margin for both sawing variation and drying can best be established by trial.

### CUT-OFF SAWING

Satisfactory cut-off saws are often built by mill mechanics to suit the class of work to be performed. Standard saws manufactured by various machinery companies are generally one of the following types: (1) A traveling table and guide moving across a stationary saw; (2) a swing saw on an arm suspended from the ceiling or pivoted from the floor pulled across a stationary bench; (3) a straight-line saw suspended on an extension arm that moves horizontally across the bench on which the piece to be cut off is placed. In some cases the straight-line saw is pulled across the bench by the sawyer, and in other cases the extension of the arm is accomplished mechanically. All the types may be operated by direct motor drive.

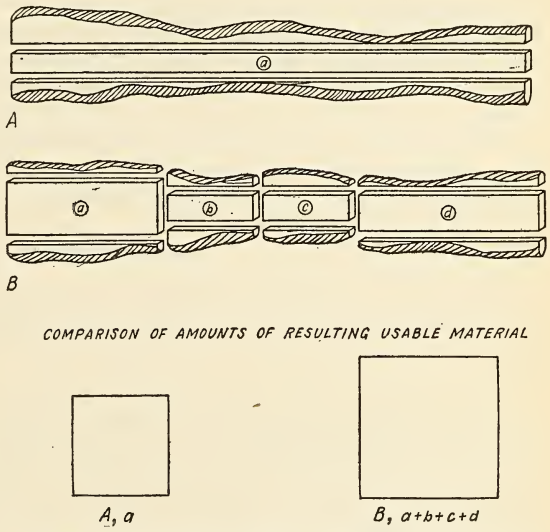


FIGURE 5.—Increased utilization results from cutting dimension stock from flitches rather than from square-edged lumber: A, Usual method of converting a flitch into square-edged lumber; B, method used in manufacturing dimension stock directly from flitches. A, $a$, and B, $a+b+c+d$, show a comparison of the amounts of usable material resulting from these two methods of manufacture

The straight-line cut-off saws are of recent development and are still rare in dimension-stock mills. However, they have been used successfully under many conditions, and, for mills wishing the latest approved machines, the straight-line saws are worth investigating. Swing saws have been used for many years, and their merits are well known. The straight-line saws are suggested as an improvement.

The maximum amount of cuttings is obtainable from flitches only when crosscutting directly follows head sawing. This is especially true when a poor grade of logs is cut and the resulting flitches are irregular in shape, as shown in Figure 5. When edging is done first, the maximum width of any cutting obtainable from a flitch is equal to the maximum width of a board free from wane that can be ripped from it. By crosscutting first, full advantage can be taken of the irregularities in outline and considerable width added to cuttings that under the method of ripping first would go into waste edgings.

When specifications permit and the stock is suitable it is advisable to save labor and simplify drying by crosscutting in multiples of cutting lengths. Under such conditions several flitches are piled together on the saw table and the entire group crosscut at one time.

For clear stock this practice has the merit of saving time, but for defective flitches it is too wasteful to be practical. To work up stock economically it is necessary to size up each flitch with a number of cutting lengths in mind and decide which of them can be used to get the greatest amount of clear material out of the piece. Good judgment is required to fit in cuttings properly between defects. As a rule major attention is given to securing the long cuts first. An abundance of short cuttings is certain to develop in spite of effort to take full advantage of every opportunity to get long ones.

In addition to the main cut-off saw, a mill manufacturing dimension stock from small logs should have a simple bench saw for odd trimming jobs. Long pieces that have been thrown out because of defects can often be recut. If a bench saw is available, an accumulation of such pieces can be worked over without interfering with the regular operation of the main cut-off saw. A cheap, homemade bench saw will serve the purpose satisfactorily.

Good methods of cut-off sawing recognize the importance of square ends. With stock that is not to be reworked at the factory and on cuttings where the trimming allowance is scant, diagonally sawed ends are a serious matter.

### RIPSAWING

Ripsawing, including the edging of flitches, is an unavoidably wasteful operation; hence, ripsaw equipment should be chosen only after a thorough study of the many types of machines available. From the crude hand-feed type no longer used in modern woodworking plants, ripsaws have been developed to the efficient high-grade, self-feed, straight-line, precision type, which has practically created new cutting quality standards. Some of the new machines have undercutting saws, some overcutting, some feed by means of a traveling bed, and others by feed rolls working from above while the bed is stationary. Some are belt driven; some have direct-motor drive. Modern machines have low, medium, and high speeds of feed. An operator might want the maximum speed possible when cutting 1-inch basswood and the slowest when cutting 3-inch maple. Guides to regulate the width of cutting are shifted from one position to another easily and quickly.

A notable advantage with the modern self-feed, straight-line ripsaws is that at the end of a day of heavy cutting stock travels through just as fast and true as at the beginning of the day. With the old type of ripsaw, speed and accuracy depend to a greater extent on the operator.

The large factory type of ripsaw represents an investment not in keeping with the scale of operation of the small dimension-stock mill. Substantial ripsaws of the same type, but smaller and cheaper, are available. Such saws are highly efficient for cutting dimension stock. It is advisable to have ripsaws that will handle stock of 3 inches maximum thickness.

As in head sawing, care must be used at the ripsaw in providing for the proper allowance for shrinkage. The width of setting for squares at the ripsaw should be exactly the same as the thickness of the flitches cut at the head saw. Table 1 will serve as a rough guide in allowing a safe margin for shrinkage. The previous

discussion of variation in sawing and distortion in drying (p. 10) applies to ripsawing as well as to head sawing, although the degree of variation in sawing is normally less in ripping.

Handling operations can be reduced by making rip cuttings of considerable length. However, when ripping out defects, there is a point at which it becomes cheaper to eliminate the defects by cross cutting even though the result is shorter pieces. Waste in edging off the wane is greater with long pieces than with short pieces because it is impossible to take the best advantage of the irregularities in the long pieces. In flitches 8 inches wide with wane on both edges the saving of material when the saw is kept in the wane, may be in excess of 3 per cent more than that when the saw is kept inside the wane.

When specifications permit, it is advisable from the standpoint of saving of labor and ease of drying to rip in multiple widths.

Ripsaws are available that have several saws set on the same arbor so that it is possible to rip several pieces from a flitch in one operation. The individual saws are set to rip 1-inch, 2-inch, or other widths, and they are stationary. The method has the advantage of speed, but since the rips must be made without respect to knots and other defects it is unavoidably wasteful in stock that is not clear. In order to work around defects to best advantage it is necessary that the operator be able to make each cut in a definite place. This is possible only with a single saw with a guide that can instantly be shifted from one position to another.

### SLASHING

The use to be made of waste and the size of the operation largely determine the type of slasher that is used to cut up slabs, edgings, and cull flitches. The mill with large output uses a slasher arrangement of several stationary circular saws hung on the same arbor. The spacing of the saws is such that material is cut either into cordwood lengths or into 16-inch stove-wood lengths. For the mill of small output the swing-saw slasher is satisfactory. Regardless of the type of slasher an operator is required to place the material to be cut in proper position.

Sometimes the sale of chips, which have been ground in a hog, is more attractive than the sale of fuel wood in the customary markets. In such an event the length of the pieces cut from waste is not so important, yet a slasher of some kind is needed to reduce the slabs and edgings to lengths that can be handled by the hog.

Ordinarily, in a dimension-stock mill with a capacity of 5,000 board feet per day per shift, slashing will not require more than one-forth of one man's time if some convenient means is provided for the accumulation of slabs and edgings until there is an amount sufficient to keep an operator engaged for periods of an hour or more at a time.

### HANDLING

The methods of inspection, sorting, bundling, and seasoning of dimension stock manufactured from small logs are so similar to those required for dimension stock from short bolts and from mill waste that they are discussed jointly under the heading "Handling and seasoning of dimension stock" (p. 39).

### EFFECT OF LOG SIZES ON MILL COSTS AND YIELDS

It is possible to determine actual costs for milling and actual yields of dimension stock for different-sized logs only if one size of log is run through the mill at a time. If several sizes of logs are run through simultaneously the records may be accurate for the average size, but the actual costs for the individual sizes making up the average may vary considerably. From the standpoint of the man who is cutting his timber with the idea that trees that will not pay their way will be left for further growth and also for the operator who is trying to handle only such timber as will be certain to show a profit, it is of utmost importance that a definite line be drawn between profitable and nonprofitable sizes of logs. In order to avoid the inaccuracies of averages, mill studies were made on logs of but a single diameter class. In other words, 8-inch logs were collected by themselves outside the mill; likewise 9-inch, 10-inch, and 11-inch. The 8-inch class included logs varying in diameter from 7.6 to 8.5 inches inside the bark at the small end; the 9-inch class, logs from 8.6 to 9.5 inches; and so on for the 10 and 11 inch classes. For each class a complete record was made of the production time for each operation, such as head sawing, ripping, and cut-off sawing. Moreover, the product from each group of logs was kept separate. Thus it was possible to compute accurately the cost per thousand board feet of producing dimension stock from each of the several diameter classes of logs. Production costs matched against market values of stock indicated the loss or gain that might be expected from logs of various diameters.

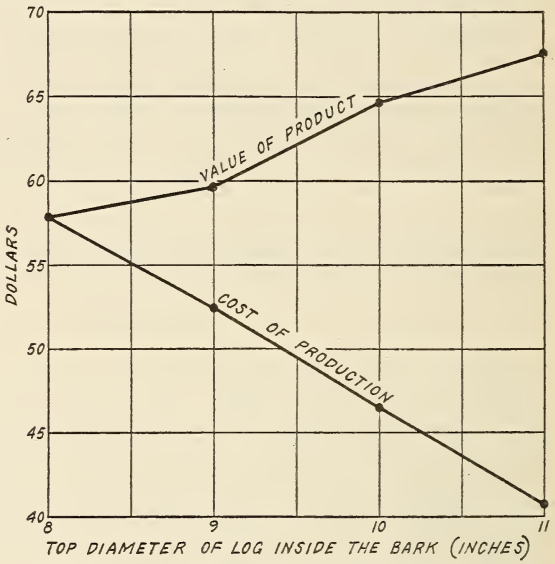


FIGURE 6.—The manufacture of dimension stock from logs greater than 8 inches in diameter shows a steady decrease in the cost of production and an increase in the value of the product per thousand board feet with the increase in diameter of log

Figure 6, which was plotted from the results of this study, shows a steady decrease in cost of production and an increase in value of product with the increase in diameter of log. For logs 8 inches in diameter the cost of production and value of product are practically the same. Consequently, logs smaller than 8 inches in diameter should be used for dimension stock only under exceptional circumstances. As diameters are increased over 8 inches there is a rapidly increasing margin for profit. Logs in the northern hardwoods with diameters greater than 11 inches become profitable enough for lum-

ber manufacture. No information has been obtained which would enable a direct comparison between the profits realized in cuttings logs over 11 inches in diameter into dimension stock and into lumber.

There is a distinct tendency among mills in the Lake States as well as elsewhere toward the manufacture of a greater variety of products and more fully refined products. Dimension stock is receiving much attention. More and more sawmills are taking over finishing operations formerly performed at consuming factories. The mills are being equipped to season and finish stock to a stage where it will be practically ready for assembly by the factory. The further extension of such methods coupled with the increasing interest in improved woods practice may be expected to affect the size of logs that may be used with profit for dimension stock. Such development may mean that it is more profitable to cut the entire woods run of logs of certain species directly into dimension stock designed for specific purposes instead of cutting the logs first to standard grades of lumber and subsequently reworking the lumber to the smaller sizes needed for fabrication purposes. Developments of this nature call for investigation as to the relative profits in lumber and in dimension stock and the advantages in the different methods of conversion.

Intensive utilization may tend to encourage cutting practices which immediately may interfere with the best timber-producing methods for the land. Land skinning for maximum immediate profit, however, is a shortsighted policy, since by leaving desirable small trees to grow and by cutting at the end of a certain period of years the possibility of far greater volumes and return per acre is realized.

The several items entering into the production costs, the value of the dimension stock from each diameter class, and the indicated margin for profit are given in Table 2. The material charge for product coming from 11-inch logs is only 47 per cent as great as that from 8-inch logs. Likewise the labor cost per thousand board feet of product from 11-inch logs was but 84 per cent as much as on the product from 8-inch logs. Even in the item, binding twine, the use of which is discussed on page 42, there is a difference in cost between stock coming from 8 and 11 inch logs. Owing to the larger amount of small stock obtained from small logs and the greater amount of twine required, there is a difference in favor of the stock from 11-inch logs of 33 cents per thousand board feet.

TABLE 2.—*Effect of size of log*[1] *on dimension-stock production costs and product values*

| Top diameter, inside bark, (inches) | Production cost per thousand board feet of product | | | | Mill value of product per thousand board feet [3] | Gain per thousand board feet |
|---|---|---|---|---|---|---|
| | Material [2] | Labor | Overhead | Total | | |
| | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| 8 | 25. 61 | 21. 77 | 10. 31 | 57. 69 | 57. 80 | 0. 11 |
| 9 | 20. 59 | 21. 53 | 10. 31 | 52. 43 | 59. 69 | 7. 26 |
| 10 | 17. 12 | 19. 10 | 10. 31 | 46. 53 | 64. 69 | 18. 16 |
| 11 | 12. 05 | 18. 37 | 10. 31 | 40. 73 | 67. 52 | 26. 79 |

[1] All logs were 8 feet long.

[2] Includes cost of stumpage, logging, delivery of logs to the mill, and binding twine. Stumpage figured at $6 per thousand board feet, gross log tally. Logging costs based on Forest Products Laboratory studies embodied in U. S. Dept. Agr. Tech. Bul. 164, Selective Logging in the Northern Hardwoods of the Lake States. Stumpage and logging costs converted from log scale to dimension-stock scale by the use of actual overrun or underrun figures. The material cost given here is high because dimension stock was the only product recovered.

[3] Based on a representative 1930 price list for air-dry northern hardwood dimension stock.

Table 3 shows the marked effect of size of the log on the cost of head sawing, ripsawing, cut-off sawing, and slashing. Sorting and bundling, the details of which are discussed on page 41, show the same degree of variation. The costs for hauling, piling, and loading dimension stock do not reflect the size of log for the reason that bundling offsets the influence of the greater number of small pieces from small logs.

TABLE 3.—*Effect of size of log on cost of certain mill operations*

| Top diameter, inside bark (inches) | Cost per thousand board feet of dimension stock of— | | | |
|---|---|---|---|---|
| | Head sawing | Ripsawing | Cut-off sawing | Slashing |
| | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| 8 | 3.38 | 2.33 | 2.08 | 1.69 |
| 9 | 3.16 | 2.42 | 2.07 | 1.58 |
| 10 | 2.46 | 1.96 | 1.70 | 1.23 |
| 11 | 2.11 | 2.06 | 1.58 | 1.05 |

The average cost of producing air-dry dimension stock from logs averaging 10 inches in diameter on a volume basis was $41.53 as shown by the following tabulation. Averaging the market value of the stock produced by the same mills gives $54.98. The difference between market value, $54.98, and production cost, $41.53, indicates a margin for profit from dimension-stock manufacturer of $13.45 per thousand board feet.

AVERAGE COST OF PRODUCING DIMENSION STOCK FROM SMALL LOGS [6]

| Cost items: | Cost per thousand board feet |
|---|---|
| Delivery of logs to log deck | $1.47 |
| Crosscutting logs and head sawing | 4.08 |
| Edging and ripping | 2.19 |
| Cut-off sawing | 1.86 |
| Sorting and bundling | 1.86 |
| Slashing waste to stove-wood lengths | 1.39 |
| Hauling stock to yard and piling | 2.46 |
| Hauling stock from yard and loading for shipment | 1.51 |
| Binding twine | .72 |
| Inspection | .40 |
| Overhead [7] | 9.27 |
| Stumpage and logging costs [8] | 14.32 |
| Total | 41.53 |

The full significance of the effect of diameter of log is appreciated only after comparing the board-foot value of the product from logs of each diameter. Owing to the increase in thickness and length of pieces as the larger logs are used there is a corresponding increase in sale value. For the same lengths 2-inch squares have a market value of from 30 to 60 per cent greater than 1-inch squares. On a 1000-foot basis, the value of dimension stock from logs 8 inches in di-

[6] The average diameter of the logs on a volume basis was 10 inches.
[7] See p. 55 for explanation of items included.
[8] The stumpage and logging costs are material costs obtained in averaging the costs from mills that produced dimension stock alone with the costs of mills that produced dimension stock along with a combination of other products.

ameter is only 86 per cent of the value of stock from logs 11 inches in diameter.

The effect of diameter of log on the size of the product, which is given in Table 4, shows in percentage of total product the amounts of various-sized squares that may be obtained when an effort is made to cut the maximum amount of large sizes.

TABLE 4.—*Effect of diameter of log on size of product*

| Size of stock [1] (inches) | Percentage of various sizes of stock cut from logs of the size stated | | | |
|---|---|---|---|---|
| | 8-inch | 9-inch | 10-inch | 11-inch |
| | *Per cent* | *Per cent* | *Per cent* | *Per cent* |
| 4/4 | 1.0 | 1.9 | 0.6 | 0.9 |
| 5/4 | 3.1 | 5.6 | 1.6 | 1.9 |
| 6/4 | 59.5 | 41.9 | 29.1 | 18.4 |
| 8/4 | 21.9 | 33.5 | 56.5 | 65.2 |
| 12/4 | | .6 | | |
| Cleats | 14.5 | 16.5 | 12.2 | 13.6 |

[1] The stock was all squares except the cleats, which were 1 by 2 inches in cross section.

The figures apply to paper birch cut primarily for squares, because the cleat stock, which was 1 inch thick by 2 inches wide, was cut from heartwood of a quality that was not suitable for first-class squares. The two points in Table 4 are especially significant: (1) The low percentage of 4/4 and 5/4 inch squares; (2) and the high percentage of 8/4-inch squares obtained from logs of 10 and 11 inch diameter.

It is rather difficult to strike an average of costs of production and market value of product for operations in which logs that vary from 7½ to 11½ inches in diameter are used, because the proportion of the various-sized logs will vary. Some operations run heavily to small sizes, some heavily to large, depending on the character of the stand, the minimum size of logs used for lumber, and other factors. Assuming that the stand is an average one of birch and maple and that the saw timber and larger tie cuts have been taken out, the remaining logs from 8 to 11 inches in diameter, inclusive, on a volume basis occur in amounts approximately as follows: 8-inch, 15 per cent; 9-inch, 33 per cent; 10-inch, 35 per cent; 11-inch, 17 per cent. Computing costs and yields on this basis give an average cost of producing air-dry dimension stock of $41.53 and an average market value of product of $62.49 per thousand board feet. The average market value of product of $62.49 is based upon one mill whereas the value of product of $54.98, given on page 16, is based upon the average of two mills, one of which was cutting larger and hence more valuable stock.

In preference to accepting these figures as applicable to any specific operation, it is suggested that actual mill studies be conducted as a means of supplying more reliable data. In view of the important bearing that the diameter of the logs has on the success of a dimension-stock operation, an operator should determine the smallest diameter of log that will pay its way. It is also essential for the prospective small-log operator to know in a general way, at least,

how much dimension stock he may obtain from a certain quantity of logs. Such information furnishes a basis for comparing the values of different classes or species of logs. Furthermore, dependable yield figures supply a definite means of comparing the efficiency of various manufacturing methods, machines, and men.

Board-foot log rules in use in the Lake States furnish an unsatisfactory method of measuring the volume of small logs. In spite of this fact, loggers and millmen are accustomed to think of volume in terms of board feet. The following figures indicate the inconsistencies of the Scribner decimal C log rule, which is commonly used in the Lake States. Eight-inch logs, when cut into dimension stock of the sizes shown in Table 4, yield a volume of product which overruns the log scale by 41.7 per cent; for 9-inch logs the underrun is 6.8 per cent; for 10-inch logs there is an underrun of 20 per cent; and for 11-inch logs an overrun of 7.1 per cent.

In considering the yields it should be borne in mind that the recovery of dimension stock from logs is not comparable with the recovery of lumber for the reason that dimension stock is a clear product or nearly so, whereas the amount of clear lumber is only a small fraction of the total produced. With a species like sugar maple, for instance, about 40 per cent of the lumber cut from an average run of logs is No. 3 Common, a grade that admits defects almost without limit.

When yields are computed on a cubic-foot basis as given in Table 5, a more accurate presentation is possible. Eight-inch logs yielded a volume of dimension stock equal to 35.6 per cent of the log volume, 9-inch logs 38 per cent, 10-inch logs 37.8 per cent, 11-inch logs 42.4 per cent. From these figures it is determined that the volume of dimension stock from logs 8 to 11 inches in diameter averages 38.4 per cent of the original volume of the logs. The minimum length of piece varied from 9 inches for 2-inch squares to 19 inches for 1-inch squares. The remainder of the log, 61.1 per cent, goes into sawdust, slabs, edgings, and trimmings. In practice, higher or lower percentages will result, depending upon the size and quality of logs, size and quality of product, thickness of saws, accuracy of equipment, and proficiency of workmen.

TABLE 5.—*Percentage of log volume yielded in dimension stock from logs of four diameter classes*

| Diameter of logs (inches) | Volume of product yielded from volume of logs | Diameter of logs (inches) | Volume of product yielded from volume of logs |
|---|---|---|---|
| | *Per cent* | | *Per cent* |
| 8 | 35.6 | 10 | 37.8 |
| 9 | 38.0 | 11 | 42.4 |

## COMBINATION OF PRODUCTS FROM SMALL LOGS

Sometimes it is practical to cut small logs into a group of products of which dimension stock is one. The other products may be railway crossties, mine timbers, mine ties, fuel, box lumber, low-grade veneer bolts, or chemical wood. Such a group permits the various

portions of the logs to be cut into the products for which they are best fitted. If a portion of a log is too rough for dimension stock it may be cut into ties or fuel, and the good portion into dimension stock. Figure 7 indicates how logs may be divided before reaching the log carriage.

An additional advantage in this method is the greater latitude offered in the selection of logs to be brought to the mill from the woods. (Fig. 8.) With a good fuel market and short log hauls, practically the only poor-quality logs of no value are those that are unsound.

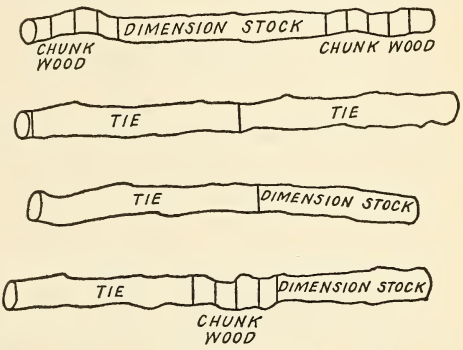


FIGURE 7.—Methods of dividing logs into short bolts

### EQUIPMENT REQUIRED FOR CUTTING A COMBINATION OF PRODUCTS FROM SMALL LOGS

The equipment required for a mill cutting various products from small logs is practically the same as for a mill designed to cut dimension stock exclusively (p. 5). Where stove-length blocks are cut for fuel, a useful addition is a circular saw installed for the purpose of splitting the larger chunks lengthwise into sizes convenient for handling.

A mill cutting various products can be operated in conjunction with the usual type of sawmill with mutual advantage to the two departments. Most sawmills operate cut-up mills in order to work

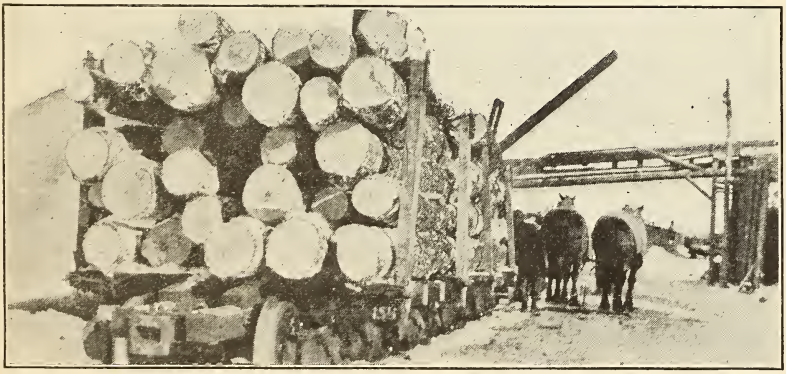

FIGURE 8.—Small and large logs arrive at the mill in mixed lots. Decision is made on the log deck as to the suitability of the individual logs for lumber or for dimension stock, ties, fuel, or other products, and the logs are accordingly sent to the proper head saw

over the best of the waste. In many cases the cut-up equipment is such that it can be utilized for cutting certain types of dimension stock. Hence, the addition of a small-log department entails only the addition of equipment necessary for cross-cutting the logs into short bolts, reducing the logs or bolts to flitches, and means for conveying the flitches to the cut-up plant. The head-saw carriage

should be of railway-tie capacity, for at times ties will form a considerable portion of the cut. Heavy slabs cut at the small-log carriage should be sent through the lumber mill for resawing, edging, and trimming. In practice good and poor, large and small logs come to the log deck in mixture. On the deck they are separated, the best logs going to the lumber side of the mill, the remainder to the dimension-stock side. The separation is made by the man on the deck in accordance with his judgment of the most profitable use of the logs.

### YIELDS AND COSTS IN A COMBINATION MILL

Studies have been made by the Forest Products Laboratory to ascertain definitely what are the possibilities in an operation where products are considerably diversified. The principal results are presented in Tables 6 and 7.

Table 6 gives the data resulting from records made in cutting 7,140 board feet, log scale, of maple logs. Table 7 itemizes the various costs indicated in Table 6.

The average diameter of the logs included in the trial runs was 10.28 inches, the smallest log was 7¼ inches, and the largest log was 13 inches. Logs were scaled according to the Scribner decimal C rule.

TABLE 6.—*Cost of producing various products from small logs* [1]

| Product [2] | Quantity | Production cost | | Sale value | | Indicated margin for profit | |
|---|---|---|---|---|---|---|---|
| | | For the lot | Per thousand board feet | For the lot | Per thousand board feet | For the lot | Per thousand board feet |
| | | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| 4/4 squares | 76.22 board feet | 2.22 | 29.14 | 3.57 | 46.84 | 1.35 | 17.70 |
| 5/4 squares | 82.11 board feet | 2.39 | | 4.61 | 56.14 | 2.22 | 27.00 |
| 6/4 squares | 140.03 board feet | 4.08 | | 8.77 | 62.63 | 4.69 | 33.49 |
| 8/4 squares | 1.55 board feet | .05 | | .11 | 68.75 | .06 | 39.61 |
| 8/4 flat stock | 667.70 board feet | 79.71 | 26.96 | 133.07 | 45.00 | 53.36 | 18.04 |
| 9/4 flat stock | 748.00 board feet | | | | | | |
| 10/4 flat stock | 1,541.30 board feet | | | | | | |
| 6/4 flat stock | 454.30 board feet | 12.24 | 26.94 | 27.26 | 60.00 | 15.02 | 33.06 |
| Mine caps | 557.10 board feet | 14.15 | 25.40 | 14.48 | 25.99 | .33 | .59 |
| Lumber [3] | 660.00 board feet | 14.22 | 21.55 | 16.76 | 25.39 | 2.54 | 3.84 |
| Ties | 86 ties | 43.89 | ---------- | 75.77 | ---------- | 31.88 | ---------- |
| Chunk wood | 5 1½ loads | 42.68 | ---------- | 45.85 | ---------- | 3.17 | ---------- |
| Slab wood | 2 1½ loads | 16.67 | ---------- | 10.41 | ---------- | (4) | (4) |
| Total | ---------- | 232.30 | ---------- | [3] 40.66 | ---------- | [4] 114.62 | ---------- |

[1] Log-deck scale (Scribner decimal C) of logs sent to dimension mill was 7,140 board feet. The smallest log was 7.25 inches in diameter, the largest log was 13 inches in diameter. The length of the logs varied from 8 to 16 feet.

[2] All squares and flat stock were air dried.

[3] Lumber was cut in the lumber mill from slabs, and other pieces of material obtained from the dimension mill.

[4] A loss of $6.26 per lot or $2.15 per load was incurred on the slab wood. The indicated margin of profit of $114.62 should therefore be reduced $6.26 leaving a net margin of $108.36. Assuming that there would be a 5 per cent loss in drying the squares, flat stock, and lumber, the net profit for the lot would be $104.50.

TABLE 7.—*Itemized cost of products from small logs*[1]

| Cost item | Cost per thousand board feet for— | | | | | Cost of ties (each) | Cost per load for— | |
|---|---|---|---|---|---|---|---|---|
| | 2-inch and thicker flat stock | Flat stock under 2 inches thick | Squares | Mine caps | Lumber | | Chunk wood | Slab wood |
| | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Flitch mill | 5.39 | 5.39 | 5.39 | 5.39 | | 0.114 | 1.07 | 1.64 |
| Dimension mill | 5.20 | 5.20 | 5.20 | 5.20 | | | | |
| Hauling | 1.09 | 1.09 | 1.09 | | 0.20 | | | |
| Piling | .58 | .58 | 1.54 | .39 | .60 | | | |
| Twine | | | .84 | | | | | |
| Tie dock | | | | | | .025 | | |
| Stumpage and log delivery [2] | 9.80 | 9.80 | 9.80 | 9.80 | 6.33 | .323 | | |
| Log delivery | | | | | | | 4.95 | 1.71 |
| Wood delivery | | | | | | | 1.96 | 1.96 |
| Material | | | | | 5.43 | | | |
| Air drying | | | | | 1.53 | | | |
| Mill production cost (including overhead) | | | | | 6.50 | | | |
| Inspection | | | .40 | | | | | |
| Loading | .96 | .96 | .96 | .70 | .96 | .02 | | |
| Overhead | 3.92 | 3.92 | 3.92 | 3.92 | | .028 | .41 | .41 |
| Total | 26.94 | 26.94 | 29.14 | 25.40 | 21.55 | .51 | 8.39 | 5.72 |

[1] The average diameter of the logs on a volume basis was 10.28 inches. The average length of the logs varied from 8 to 16 feet.

[2] Stumpage and log delivery are low because the recovery of mine caps, lumber, ties, chunk wood, and slab wood was combined with that of dimension stock.

Aside from mill costs, production costs include stumpage values in some cases and logging and delivery costs in all cases. Ordinarily small and inferior logs are given no stumpage value. However, for the purpose of the study, where a combination of products was made from small logs it has been considered advisable to charge dimension stock, ties, and mine caps with stumpage at the rate of $6 per thousand board feet, net log scale; the same value commonly assigned to Lake State hardwood saw timber. Chunk wood, side lumber, and slab wood were given no stumpage charge. However, side lumber was given a material charge equal to its value as slab wood.

Logging costs were the actual costs of delivering to the mill logs that averaged 10 inches in diameter. In accordance with customary practice, permanent-improvement charges, such as railroads and bridges, were not included. It is customary to consider that permanent-improvement costs properly should be absorbed by the primary product, that is, by the saw logs taken out for lumber. Naturally when small logs form the major part of the cut from an area the permanent-improvement costs should be charged against the small logs.

Mill costs were separated as closely as possible into individual items of which they were composed, such as head sawing, ripping, trimming, inspection, loading, and overhead. Air-drying costs were covered in the hauling, piling, dry-shed and stock-investment, and depreciation items. Each product was considered separately, for all cost items did not apply to every product. For instance, ties carried no machining costs beyond the head saw, no hauling, piling, inspection, or twine costs.

### PERCENTAGE OF RECOVERY IN CUTTING DIMENSION STOCK AND OTHER PRODUCTS FROM SMALL LOGS

Products from the lot of small logs developed in quantity the following percentages: Dimension stock, 25.82; lumber, 4; ties, 15.94; chunk wood, 36.11, slab wood, 7.14; and waste, 10.99. Owing to the large volume of the product in forms to which the board-foot measure can not be applied with any approximation to accuracy, it is impractical to compute percentage of recovery on the basis of board-foot volume. Converting both logs and product into cubic measure gives a truer indication of the recovery. The volume of logs included in this test run was 1,377.80 cubic feet. The volume of the product cut from the logs was 1,226.33 cubic feet. From these two figures the product accounted for is shown in Table 8 to be 89.01 per cent of the volume of the logs. A margin of 10.99 per cent remains to cover the waste in saw kerf and a small amount of slabs, edgings, and trimmings developed in resawing slabs sent through the resaw, edger, and trimmer on the lumber side of the mill.

TABLE 8.—*Mill product of small logs*

| Kind of product | Amount cut | Board-feet conversion figure | Equivalent to— | Equivalent to— | Percentage of gross volume of dimesion stock logs recovered |
|---|---|---|---|---|---|
| | | | *Board feet* | *Cubic feet* | *Per cent* |
| 4/4 squares | 76.22 board feet | 1 | 76.22 | | |
| 5/4 squares | 82.11 board feet | 1 | 82.11 | | |
| 6/4 squares | 140.03 board feet | 1 | 140.03 | | |
| 8/4 squares | 1.55 board feet | 1 | 1.55 | | |
| 8/4 flat stock | 667.70 board feet | 1 | 667.70 | 355.70 | 25.82 |
| 9/4 flat stock | 748.00 board feet | 1 | 748.00 | | |
| 10/4 flat stock | 1,541.30 board feet | 1 | 1,541.30 | | |
| 6/4 flat stock | 454.30 board feet | 1 | 454.30 | | |
| Mine caps | 557.10 board feet | 1 | 557.10 | | |
| Lumber | 660.00 board feet | 1 | 660.00 | 55.00 | 4.00 |
| Ties | 86 ties | 30.64 | 2,635.04 | 219.54 | 15.94 |
| Chunk wood | 497.64 cubic feet | 8 | 3,981.12 | 497.64 | 36.11 |
| Slab wood | 98.40 cubic feet | 8 | 787.20 | 98.40 | 7.14 |
| Total | | | 12,331.67 | 1,226.28 | 89.01 |

The percentages of the various products given in Table 8 are not fixed. Fluctuations might be caused by a number of factors. If the logs are smooth and straight the percentage of dimension stock might be considerably higher or if the price of ties was unusually attractive the percentage of ties might exceed that of dimension stock. There is less waste in cutting ties than in cutting dimension stock and less waste with fuel wood than with ties; hence, the waste figures would vary according to the volumes of the primary products.

The logging of woods waste for the manufacture of dimension stock from small logs and the methods of log measurement are so similar to those for the manufacture of dimension stock from short bolts that their discussion has been combined and is presented on pages 28 to 31.

### DIMENSION STOCK FROM SHORT BOLTS

The production of dimension stock from bolts is the oldest of the cutting methods used in this country. Essentially it consists of cutting small or inferior logs or wood waste into bolts of approxi-

mate cordwood length in the woods or at the mill. After being cut into bolts, the material may be sawed into flitches, or it may be sawed by the turning-down method. The manufacture of dimension stock from short bolts has an advantage in that a larger percentage of the log may be utilized by cutting it into short lengths than by any other method. (Fig. 5.) It has been standard practice in the New England States ever since the textile industries began to draw on that section for their supplies of spool wood. For many years ash and hickory cut in cordwood length have been a common form of raw material for handle plants, as have also dogwood and persimmon for shuttle blocks.

Since equipment suitable for use with long logs is ineffective with short bolts, special machinery has been designed and is usually employed in milling bolts. Naturally the equipment for short bolts is much lighter than for long logs. The methods used require more hand work and less machinery. Investment in mill and layout is

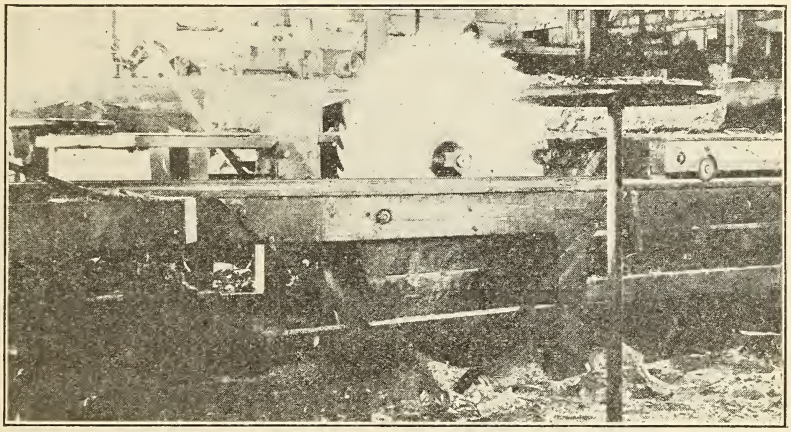

FIGURE 9.—The so-called "snapdragon" type of head saw is standard equipment in the Northeastern States for cutting small bolts of cordwood length. The carriage is operated by hand power

considerably less than for a mill equipped to cut lumber from logs. The entire cost of building and machinery suitable for the manufacture of dimension stock from short bolts is from $2,500 to $3,500 at 1930 prices.

In actual practice bolts are usually cut by the cord in the woods, loaded by hand into wagons, sleighs, or trucks, and hauled to the railroad or direct to the mill. Here again unloading is by hand to storage piles or direct to log deck. Generally bolts are rolled up to the saw with a cant hook.

### HEAD SAWING

Head saws used for strictly bolt mills are somewhat different in type from those used in mills cutting short logs. For small bolts simple hand-operated machines are still used with fair success. These machines consist of a movable bench on which the bolts are placed and pushed by hand against the saw. There are no mechanical means on the machine for setting and "dogging" the bolts. Figure 9 illustrates the so-called "snapdragon" type of head saw

which is ordinarily used in the New England States for sawing small bolts.

Power-driven carriages, such as shown in Figure 10, are commonly used at mills designed to handle bolts too large for effective hand operation.

Band mills of a highly refined type have not come into common use in bolt mills. They are a development suitable only for the more permanent and substantial class of mills.

The methods of head sawing that are employed depend largely upon the size of bolts, species, and kind of product manufactured. Large bolts may be reduced to cants that can be conveniently handled by the ripsaws. Small bolts may be reduced to flitches; that is, sawed through and through, in such manner that each piece has two barky edges. (Fig. 11.) When it is desirable to get the maximum amount of sapwood separated from the heartwood the bolts may be cut by the turning down or box-heart method (p. 9).

The crew that operates a head saw in a small bolt mill consists of one or two men. With the simplest form of carriage the sawyer

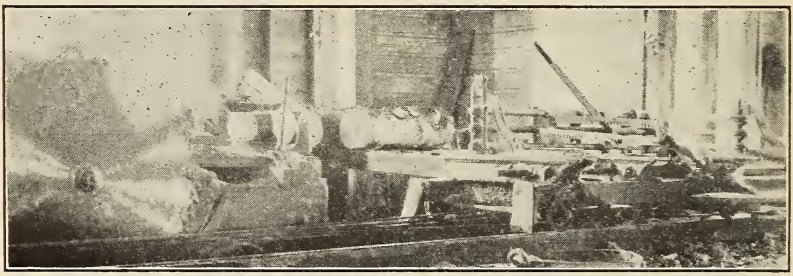

FIGURE 10.—A short-log, power-driven carriage and a circular saw are effective equipment for cutting bolts that are too large to be easily handled with the common "snapdragon" type of head saw

has no helper, but with other types of carriages the sawyer may do the setting while a second man does the "dogging." Generally a tail sawyer disposes of the slabs and carries the flitches to the next machine.

### RIPSAWING

The service required from bolt-mill ripsaws, so-called "strippers," is so different from that expected from the factory type that special equipment is almost universally used. Figure 12 illustrates one of several types of machines that have given satisfaction. It has the advantages of low initial cost, light weight, and easy and rapid adjustment for different widths of stock. Two strippers will handle the output of one head saw.

The crew that operates a stripper consists of one man feeding and one off-bearing. The work is exceedingly strenuous; hence, the men alternate jobs frequently. The operation directly follows the head sawing. In birch and maple the sawing is performed in a manner that will make the most dimension stock out of the clear sapwood.

### TRIMMING

Generally the elimination of defects by crosscutting is done after the dimension stock has seasoned. Where the product is turning squares, the defects are usually eliminated at the lathes instead of being cut out in a separate operation. A discussion that is applicable to cut-off saws for the manufacture of dimension stock from short bolts, appears on pages 11 to 12.

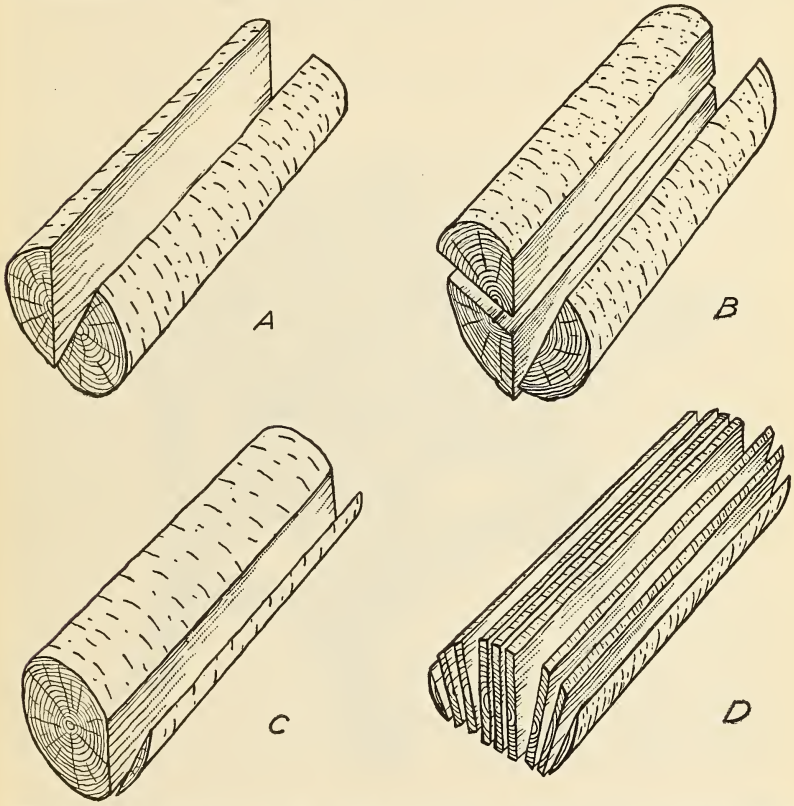


FIGURE 11.—Previous to ripping, bolts are reduced to sections or flitches. Methods used depend somewhat on the diameter of the bolts. Bolts under 8 inches in diameter generally cut into two or three sections, as shown in A and B. When the bolts exceed 8 inches in diameter it is common practice to slab one face, as in C, then turn the sawed surface down and saw the bolt through and through as in D

### HANDLING

In addition to the crews for the head saw and for the stripper the following men are needed in a bolt mill: One or two to bring the bolts up to the log deck, one or two to sort and count the squares, one to tie edgings, one spare man, one foreman and millwright, one fireman.

The methods of inspection, sorting, and bundling, and seasoning of dimension stock manufactured from short bolts are so similar to those required for dimension stock from short logs and from mill

waste that they are discussed jointly under the heading "Handling and seasoning of dimension stock," page 39.

### YIELD OF SQUARES FROM BIRCH BOLTS

The amount of dimension stock that can be cut from a cord of wood varies greatly according to the straightness and soundness of the sticks and to the specifications that govern the size and quality of the manufactured stock. A study by the Forest Products Laboratory of an operation in the Lake States showed that a cord of 4-foot bolts yielded 332 board feet in squares. On the same basis, New England birch yielded 417 board feet per cord of bolts. In both cases the ranges in size and quality of squares were approximately

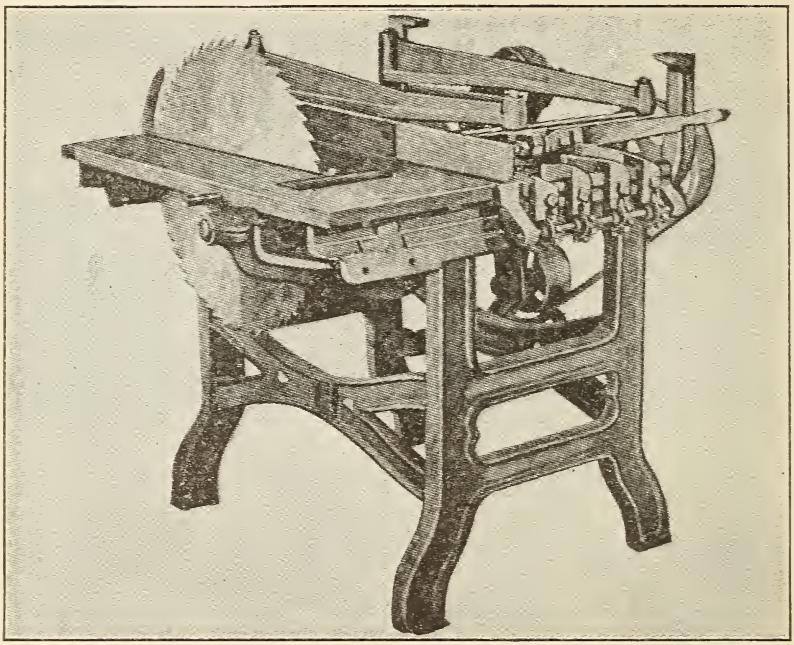

FIGURE 12.—A common type of ripsaw or "stripper" used in the Northeastern States for cutting squares from the flitches coming from the head saw. It has the advantages of cheapness, simplicity, accuracy, and can be quickly adjusted

the same. The yield in sawed stock is also dependent upon the size of the bolts. In the two instances just cited, the bolts in the Lake States timber averaged 9.8 inches in diameter outside the bark; in the New England States timber they averaged 6.8 inches in diameter.

### HEARTWOOD OF PAPER BIRCH IN LARGE AND SMALL BOLTS

Except for the heartwood, a factor that in a large measure determines the quality of birch squares, large bolts would show a greater yield than small ones. For certain uses consumers refuse to accept heartwood; hence, producers waste much of it in striving for a high yield of sapwood. Sapwood is greatest in percentage of total volume in young trees and least in large, mature trees. The Lake States

birch on which the foregoing trial runs were made, was of the older, overmature type, such as that occurring in mixture with mature softwoods, whereas the New England timber was that growing in the practically pure younger stands typical of New England. The difference in type of timber accounts for the large difference in the percentage of heartwood. Actually birch in the Lake States yielded 29.3 per cent of its volume in red heartwood, while the maximum in the New England timber was 13 per cent. However, there is no evidence to show that there is a difference in the heartwood and sapwood content between timber from the two regions, provided the age and size are the same.

The percentages of heartwood and sapwood, which were obtained from the measurement of 367 birch bolts from the Lake States, are given in Table 9. The bolts were all of the class of timber growing in mixture with softwoods, such as pine, spruce, and balsam. A few yellow birch bolts were included with this lot, since measurements on paper and yellow birch showed no consistent difference between the two species with respect to the relation of volume of sapwood and heartwood to diameter classes.

TABLE 9.—*Percentages of sapwood and heartwood in paper and yellow birch from the Lake States* [1]

| Diameter class (inches) | Average width of sapwood | Average diameter of heartwood | Volume in a 4-foot bolt | | | | |
|---|---|---|---|---|---|---|---|
| | | | Sapwood | | Heartwood | | Total |
| | *Inches* | *Inches* | *Cubic feet* | *Per cent* | *Cubic feet* | *Per cent* | *Cubic feet* |
| 5 | 1.92 | 1.16 | 0.516 | 94.7 | 0.029 | 5.3 | 0.545 |
| 6 | 2.17 | 1.66 | .725 | 92.4 | .060 | 7.6 | .785 |
| 7 | 2.22 | 2.56 | .926 | 86.6 | .143 | 13.4 | 1.069 |
| 8 | 2.01 | 3.98 | 1.050 | 75.2 | .346 | 24.8 | 1.396 |
| 9 | 1.98 | 5.04 | 1.213 | 68.6 | .554 | 31.4 | 1.767 |
| 10 | 2.08 | 5.84 | 1.438 | 65.9 | .744 | 34.1 | 2.182 |
| 11 | 2.63 | 5.74 | 1.921 | 72.8 | .720 | 27.2 | 2.641 |
| 12 | 2.45 | 7.10 | 2.042 | 65.0 | 1.100 | 35.0 | 3.142 |
| 13 | 1.74 | 9.52 | 1.710 | 46.4 | 1.977 | 53.6 | 3.687 |
| 14 | 3.18 | 7.64 | 3.003 | 70.2 | 1.273 | 29.8 | 4.276 |
| 15 | 3.05 | 8.90 | 3.180 | 64.8 | 1.728 | 35.2 | 4.908 |
| 16 | 3.35 | 9.30 | 3.697 | 66.2 | 1.887 | 33.8 | 5.584 |
| 17 | 3.79 | 9.42 | 4.368 | 69.2 | 1.936 | 30.7 | 6.304 |
| 18 | 2.65 | 12.70 | 3.549 | 50.2 | 3.520 | 49.8 | 7.069 |
| 19 | 3.25 | 12.50 | 4.466 | 56.7 | 3.410 | 43.3 | 7.876 |
| 20 | 3.25 | 13.50 | 4.748 | 54.4 | 3.980 | 45.6 | 8.728 |

[1] Based on 367 measurements.

Table 9 does not show an entirely consistent increase in the percentage of heartwood with increase in diameter of bolt. Nevertheless, over all the increase is pronounced, for from 5 inches in diameter to 20 inches the volume of heartwood increased from 5.3 per cent to 45.6 per cent.

In northern hardwoods other than paper birch, the demand for sapwood is not so insistent. For ordinary fabricating purposes heartwood is readily accepted if it is as sound and as free from defects as the sapwood.

## COSTS OF PRODUCING AIR-DRY SQUARES FROM BOLTS

Cost studies were made at five bolt mills. The average size of square produced from 800 cords of bolts that averaged about 7 inches

in diameter was $1\frac{9}{16}$ inches. The production cost was $47.29 per thousand board feet, of which $13.10 was for mill labor and overhead and $34.19 was for material.

One cord of birch bolts yielded 417 board feet of squares or at the rate of 2.4 cords per thousand board feet of squares. With an average cost per cord of $16.60, the cost of bolts required to produce 1,000 board feet of squares was $39.84. However, the value of slabs and edgings from the production of 1,000 board feet of dimension stock was $5.65. Deducting this amount from the cost of bolts, the net cost of material required for the production of 1,000 board feet of squares was $34.19.

The average size of dimension-stock squares produced in each of the five mills that were studied varied from $1\frac{5}{16}$ to $1\frac{12}{16}$ inches, but a corresponding variation in production costs did not occur because there were other factors that affected costs more than did the size of squares.

### WASTE DISPOSAL

The usual outlet for waste from the manufacture of dimension stock from short bolts and small logs is through local fuel markets. The value of fuel is high or low depending upon the local prices of competitive fuels, such as coal, oil, or gas. Sometimes waste is sold to large fuel companies who act as middlemen for bolt mills and consumers. Where a fair price can be obtained, this method has a great advantage in that it relieves the mill of the burden of making local deliveries and of carrying a large number of accounts. In some cases thin edgings are cut in 2 or 4 foot lengths, bundled, and sold to railroads for locomotive kindling.

Occasionally there is a market for sawdust, chiefly hard maple. Some mills find it preferable to market through sawdust and shaving companies that deal in these products on a large scale in the larger cities, such as Chicago and Milwaukee. For the mill the margin for profit on sawdust is small, but even so it may yield a greater return when sold than when burned under the boiler or when dumped as refuse. Sawdust is either loaded loose in box cars or bagged before loading.

The importance of the disposal of waste may be illustrated by the instance of a small mill whose entire cost for labor was paid from the profit on slabs and edgings and whose cost for electric power was practically paid from sawdust sales.

### LOGGING WOODS WASTE

Opinion is divided with respect to how and when woods waste should be logged. The use for which the waste is intended is one of the chief determining factors, but as a rule most considerations are best served if the inferior material is removed along with the saw logs or as soon after as practicable. The reasons in support of such procedure are the following: (1) Logging improvements can be utilized before they deteriorate; (2) minor additions or alterations in lumber-mill equipment and layout can be adapted for handling and cutting the smaller and poorer logs at costs that are appreciably lower than where special machinery is set in motion for utilization at some subsequent time; (3) unavoidable damage resulting to second

growth is reduced; and (4) the damage to logs through stain, decay, and checking, and wood-boring insects is reduced.

Timber operators who have never been faced with high stumpage prices or complete stumpage depletion have naturally been hesitant about incurring the risk of slowing down the routine of their lumber operation by attempting more effective utilization of inferior logs with new problems and difficulties to be solved. It has been usual, therefore, for a lumber company to go into an area and remove the timber of saw-log size and subsequently dispose of other material to railway-tie or fuel cutters, or to small box-board mills, or the like. More recent developments indicate that the large sawmills operating primarily for saw logs are weighing carefully the practicability of employing their own facilities for the manufacture of some kind of by-product from woods waste. In cases where it has been found advisable to engage in woods-waste utilization, both saw logs and inferior logs have been removed at the same time.

Another idea that has received some consideration and trial is that of taking a portable mill into a logging area to cut up the poorer logs right on the ground, the better logs going to the stationary lumber mill. This method has an advantage in that the unusable portions of logs are left in the woods instead of being transported considerable distances and then disposed of, as is the case when the logs in their original form are hauled from the woods to distant mills. Moreover, the overhead expenses that are unescapable are less with the portable mill in the woods. Where this method is employed it should go hand in hand with the primary saw-log operation for the reasons previously stated and for the additional reason that it tends to reduce the temptation to transport to the lumber mill logs that will not pay their way.

### LOG LENGTHS

Practices vary with respect to the length of log delivered to the sawmill. As a rule a given volume can be handled more cheaply in the form of long logs than as short ones; hence, an effort is usually made to cut logs no shorter than 8 feet. If advisable, the long logs are cut to suitable short lengths upon their arrival at the mill. This method precludes making the most of the short clear lengths that are available in the woods, for by reducing the log length from 8 to 4 feet, or to cordwood length, the volume removed may be appreciably increased. For this reason bolts are sometimes delivered in standard cord lengths. An additional advantage is gained in that it is possible to cut so as to deliver material that will work up with less waste than is possible with long logs. Defective portions, which tend to increase production costs, can be eliminated in the woods. Delivery of bolts in cordwood lengths is standard practice where paper birch is cut into squares for spools and other small turnings. The delivery of long logs to such mills is exceptional. In view of the fact that there is an appreciable demand for dimension stock over 4 feet long there always will be necessity for some logs up to 8 and even 10 feet long.

### BOARD MEASURE

The measurement of small bolts and short logs on the basis of their contents in board feet introduces a large element of uncer-

tainty. The Scribner decimal C log rule, which is commonly used in the Lake States, gives very inconsistent results.

According to the rule a log 10 inches in diameter and 16 feet long scales 60 board feet, and a log 8 feet long of the same diameter scales 30 feet. Actually the 16-foot log has considerably more than twice the volume of the 8-foot log because of the appreciable difference in size between the small and big ends of the longer log.

Again the Scribner decimal C log rule assigns a volume of 30 board feet to a log 10 inches in diameter and 8 feet long—precisely the same scale as for a log 11 inches in diameter and 8 feet long.

It is apparent from these illustrations why overrun figures are unstable when applied to products from small logs.

### CUBIC MEASURE

It is possible to apply cubic measure to logs and obtain volumes that are accurate. With small logs it is especially desirable, although even with large logs it is far more accurate than board measure. Wherever accuracy is of prime importance there is no substitute for cubic measure.

To determine volume it is only necessary to obtain the area in square inches of a circle having a diameter equal to the diameter of the log inside the bark at a point midway between the two ends and multiply this figure by the length of the log in inches. An average of the two end diameters may be taken as the middle diameter. The volume of the log in cubic inches is then divided by 1,728, and the result is the volume in cubic feet. This method is sufficiently accurate for practical purposes. Tables are available that give areas of circles of different diameters.

If the product cut from the logs is square edged its volume can be easily determined. This volume in cubic feet divided by the log volume gives the percentage of the log recovered in the form of sawed product.

Figures for converting cubic feet to board feet are rather arbitrary ones. Theoretically 1 cubic foot is equal to 12 board feet. However, if a cubic foot of wood is sawed into boards there will be saw kerf loss that will reduce the number of board feet to less than 12, how many less is dependent upon the gage of the saw. A conversion figure commonly used is 7 board feet from 1 cubic foot of material from average woods-run logs.

### CORD MEASURE

A standard cord measures 4 by 4 by 8 feet and occupies 128 cubic feet of space. Actually the solid contents of the cord is somewhat less. A cord may contain as little as 60 solid cubic feet of wood, or as much as 100, depending upon the size, form, and shape of the sticks. An average figure commonly used is 90 cubic feet. Extra measurements are sometimes used to account for the volume of the bark. On such a basis, a cord measures 4 feet by 4 feet 4 inches by 8 feet and occupies 138⅔ cubic feet of space.

In commercial practice a standard cord is usually considered as the equivalent of 670 board feet of 1-inch lumber, or, in other terms, a thousand feet of 1-inch lumber is equal to 1½ cords of wood. On

this basis cords are converted into thousands of board feet simply by multiplying the number of cords by two-thirds.

Table 10 shows for each diameter from 4 inches to 16 inches the number of bolts per cord and the solid contents per cord in cubic feet. Table 10 is based on the measurements made by the Forest Products Laboratory on several hundred cords of woods-run bolts of paper birch.

TABLE 10.—*Solid contents per stacked cord of 128 cubic feet, gross volume, of paper birch bolts of various diameters*

| Average diameter of bolt, (inches) | Bolts per cord | Solid wood per cord | Average diameter of bolt, (inches) | Bolts per cord | Solid wood per cord |
|---|---|---|---|---|---|
| | *Number* | *Cubic feet* | | *Number* | *Cubic feet* |
| 4 | 164 | 57.2 | 11 | 33 | 87.1 |
| 5 | 132 | 72.0 | 12 | 28 | 88.0 |
| 6 | 102 | 80.1 | 13 | 24 | 88.5 |
| 7 | 78 | 83.4 | 14 | 21 | 89.8 |
| 8 | 60 | 83.8 | 15 | 19 | 93.3 |
| 9 | 48 | 84.8 | 16 | 17 | 94.9 |
| 10 | 39 | 85.1 | | | |

## DIMENSION STOCK FROM MILL WASTE

Sawmills in the Lake States make use of slabs, edgings, and trimmings in many ways as a means of supplementing the lumber product of the log. Lath is a standard by-product of sawmills cutting softwoods, and some of the waste of the softer hardwoods is also made into lath. Other products from hardwood waste are short and narrow flooring strips, box boards, crating strips, surveyors' stakes, fence pickets, bakers' wood, fuel wood, and dimension stock of various forms.

Dimension stock cut from mill waste is neither new nor uncommon in the Lake States. For many years sawmills have been making broom-handle squares, chair stock, turning squares, and in fact a miscellany of stock for which there might be markets. In spite of the general practice there never has been any really active interest in this method of wood utilization. The dimension-stock business has been carried along until recent years with no particular attention to the development of methods or machinery that would make it profitable.

A sawmill cutting dimension stock from mill waste has some distinct advantages over a mill using logs as raw material. Mill waste is cheap, and in producing it some of the first machining stages are accomplished that are incidental to lumber production. Work on waste is usually possible at a low charge for space, power, and mill equipment. In many cases the manufacture of by-products absorbs material, labor, and overhead that otherwise would be wasted. However, the supply of mill waste is entirely dependent upon the operation of the mill; hence curtailment of lumber production may seriously interfere with the dimension-stock output. The fact that the raw material is waste to begin with encourages the tendency of workmen to handle stock carelessly. This fact, together with the use of machinery not especially well adapted for cutting dimension stock, accounts for the difficulty some mills encounter in producing dimension stock of the quality demanded by factory operators.

## QUANTITIES AND SIZES OF DIMENSION STOCK AVAILABLE FROM MILL WASTE

In the class of mill waste are included slabs, edgings, trimmings, and in some cases boards below grade. The yield of dimension stock from mill waste varies considerably from one mill to another depending upon the methods followed in lumber manufacture, efficiency of labor and equipment, species and quality of logs, and upon the effort that is made to recover as much as possible of the usable material. Some mills cut for quality lumber at a sacrifice of more material in the form of slabs, edgings, and trimmings. Others may cut a high percentage of railway ties, timbers, or other special products that directly influence the amount of waste. There are instances where dimension stock is salvaged from edgings but not from slabs and trimmings. In some cases slabs are resawed with band or circular resaws of either horizontal or vertical type, but in most mills they are cut directly into dimension stock without resawing.

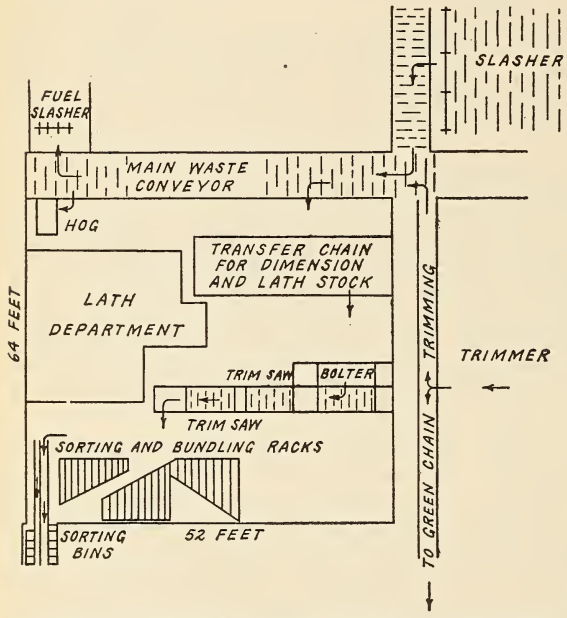


FIGURE 13.—Layout of a typical dimension-stock mill operating on mill waste in conjunction with a large sawmill

Figures obtained in studies at three similarly operated sawmills which were cutting a mixture of northern hardwoods but were reworking only the birch and maple waste, show a percentage of recovery of dimension stock based on net log scale of about 4 per cent. In other words, for every thousand board feet of maple and birch logs cut, about 40 board feet of dimension stock were cut from slabs, edgings, and trimmings. At each of the three mills the major portion of the stock recovered was in the form of 1-inch squares.

Under average conditions logs yield about 55 per cent of their volume in lumber that will meet the specifications of standard grades. The remaining 45 per cent consists of miscellaneous forms of waste, some of which contain the clearest and soundest part of the log.

In most modern sawmills slabs are cut fairly heavy and then sent to the resaw for further reduction. (Fig. 13.) Other mills have no resaws but slab very lightly at the head saw, and still others operate gang saws. In any event, the good material left in slabs is short and wide, though it may be thick. It may also be more or less cross-grained.

Usually, edgings contain long, narrow cuttings, many of which are thin because of the fact that by far the greater cut of lumber is 4/4 and 5/4 inch in thickness. Edgings which, as a rule, come from the outer edge of the boards, tend to have a high percentage of clear straight-grained sapwood.

Trimmings are short and wide and, like edgings, they are thin in about the same proportions that lumber is cut; that is, 5/4 inch and under in thickness. Trimmings contain a high percentage of clear straight-grained stock.

It would be reasonable to expect, therefore, that short, thick, wide stock could be cut from slabs; long, thin, narrow stock from edgings; and short, thin, wide stock from trimmings. Naturally, there will be some variation from the average. Edgings from thick lumber will yield long, thick, narrow stock, but the volume of such edgings will not be great.

Crooked, defective logs result in heavy slabs, edgings, and trimmings. Hence, the amount and dimensions of cuttings recoverable from mill waste will vary within rather wide limits, depending upon the quality of logs with which the mill is supplied. Generally speaking, however, mill waste can not be expected to yield enough large cuttings to meet the normal demands of the dimension-stock trade. Some of the large dimension-stock sizes must come from low-grade lumber or direct from logs or bolts.

### SAVING LONG EDGINGS

Since in standard sawmill installation the saws in the slasher are set 49 inches apart, waste that passes into the main conveyor has a maximum length of 49 inches. For the bulk of the waste this length is satisfactory. However, since long cuttings have a greater market value than short ones it is worth while to consider the ways in which different mills manufacturing dimension stock utilize long slabs and edgings. The following are methods that have been observed: (1) All waste passes stock pickers before going through slasher and the long desirable pieces are sorted out; (2) a man behind the edger sorts out the long edgings, places them on a special transfer which leads direct to the dimension mill; (3) at either end of the slasher wide gaps are left into which are pulled the desirable long slabs and edgings, thence they pass into the main conveyor and are conveyed to the stock pickers in the usual way; (4) an edging catcher allows long edgings to pass on to a trim table to be trimmed along with lumber instead of pushing them on to the transfer leading to the slasher. From the trimmer they are passed into the main waste conveyor and up to the stock pickers.

Thus, by various simple methods it is possible to preserve the values in long lengths. Details of methods can best be worked out by the individual mills, for installations vary enough to make the problem of each plant distinct from those of other mills.

The sizes of dimension stock available from waste and the sizes actually cut vary widely, depending upon the markets that have been developed, supervision given to dimension-stock mill operators, and the kind of machinery used. Ordinary lath machinery is better adapted for cutting small squares than for other shapes and sizes

of stock. At one mill cutting 4/4, 5/4, 6/4, and 8/4 inch squares the average size on a volume basis was 1.17 inches in cross section by 35.65 inches in length. A tally indicated that the mill was cutting about 80,000 board feet of lumber per day, and that from the edgings and trimmings, excluding slabs, there was available slightly in excess of 2,000 board feet per day of flat stock in thicknesses up to 2 inches, lengths up to 48 inches, and in widths ranging from 2 to 8 inches. With more effective recovery of flat stock from slabs, the amount of dimension stock available per day might be increased at least one-half, thus making a total of 3,000 board feet per day. (Fig. 14.)

An another mill where only edgings and trimmings were cut into dimension stock the average size of squares was 1.23 inches in cross section by 31.8 inches long. Sixty per cent of the total volume of squares produced was squares of 1-inch thickness, the remaining 40

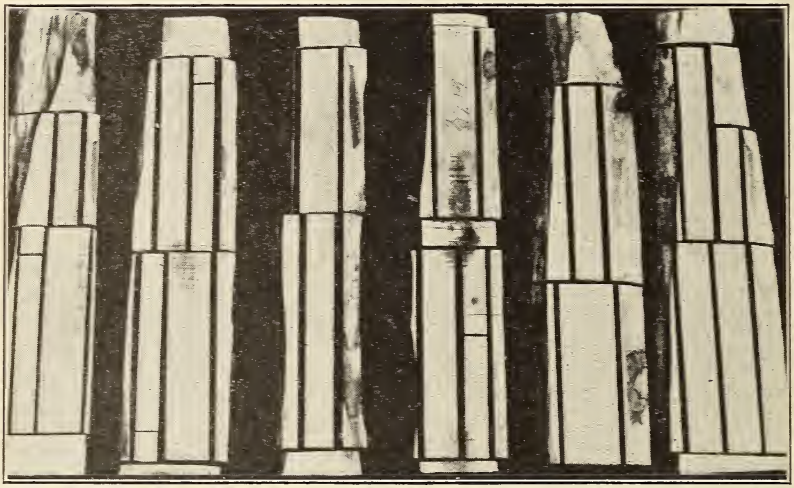

FIGURE 14.—In cutting dimension stock from resawed slabs and jacket boards, material is saved if crosscutting precedes ripping. This sequence of operations makes it possible to take advantage of the irregularities in the waney edges. The result is shorter but wider stock. The picture shows slabs which were crosscut before they were ripped into dimension stock

per cent of the volume was divided among 5/4, 6/4, and 8/4 inch squares.

Where squares form the major part of the yield the amount of stock recovered from waste varies from about 2 per cent to 6 per cent and averages 4.2 per cent of the net scale of the logs. At the mills where the dimension-stock yield was highest close observation of the waste in the conveyor after the stock pickers had taken out the better pieces showed that there remained but little material that would yield squares in sizes over 1 by 1 by 12 inches. Naturally, there is a certain point beyond which it is not profitable to pick waste from the conveyor. For instance, if a slab will yield no more than a 1 by 1 by 12 inch square it is doubtful if it pays to put it through the machines. The lower limit has not been determined, but in practice mills pick all waste that will yield 1-inch squares 16 to 18 inches long. At $35 per thousand board feet a square 1 by 1 by 18

inches is worth less than one-half cent; hence there can be but a slight margin for profit between labor cost and sales value for material of this size.

### LATH-MILL METHOD OF CUTTING DIMENSION STOCK

Mills equipped to cut lath customarily employ the same methods and machinery for cutting dimension stock. The first step is to pick from the conveyor the best pieces of waste. This is sorted in various ways and then put through a lath bolter, which reduces the rough material to strips. In the next operation the strips are cut by a lath mill into squares, following which a circular cut-off saw is used to cut out defects and trim squares to desired lengths. Sorting, and in most cases bundling, are the final mill operations.

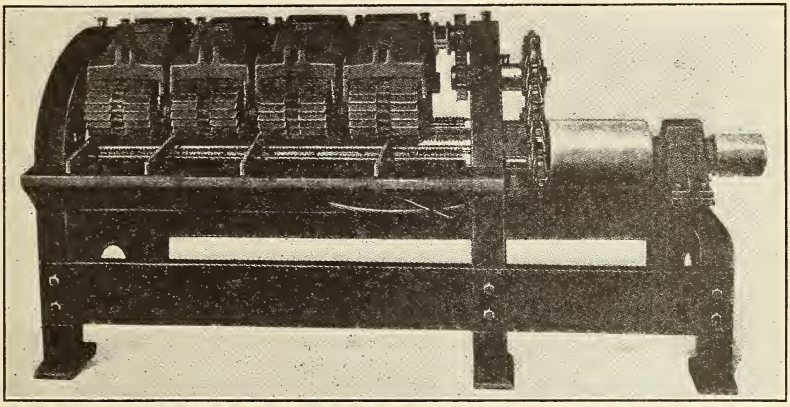

FIGURE 15.—A multiple-guide dimension-stock mill is designed for speed, convenience, and compactness. Its independent sections cut unassorted mill waste quickly and effectively into squares ranging from 4/4 to 8/4 inches and flat stock up to 12 inches wide. The three sections on the left have stationary guides and are equipped with saws in gang arrangement. The section on the right has a movable guide and a single saw adjustable to a wide range of sizes

The large quantities of squares produced by lumber mills is accounted for by the fact that lath-mill equipment is best adapted for squares or near squares.

### MULTIPLE-GUIDE MILL METHOD OF CUTTING DIMENSION STOCK

Two standard pieces of equipment in a lath mill are the lath bolter and the lath mill. The bolter takes the mill waste as it comes from the conveyor and rips it into rough strips. The lath mill in turn rips the strips to pieces of the desired width and thickness. Recently there has been introduced to the dimension-stock industry a machine that combines the operations of lath bolter and lath mill. (Fig. 15.) The advantage in this machine is its flexibility. Stock coming from the waste conveyor need not be sorted before it is fed into the machine. Depending upon the size of square that can be cut from it, a piece of waste is fed into one of four sections that are provided on the machine, or, if suitable for flat stock, the waste is fed into the section on the right which cuts both large squares and flat stock. The machine can be operated effectively by a crew of

either two or four men. Apparently, however, there is a slight advantage in favor of a 2-man crew. A multiple-guide dimension-stock mill has much in its favor, especially for operations where one of the important considerations is to put a large volume of waste through the machines in the minimum length of time.

### COMPARISON OF LATH-MILL AND MULTIPLE-GUIDE-MILL PRODUCTION RECORDS

On comparing in a detailed way the production-time records of two mills, one using ordinary lath bolter and lath mill, and the other a multiple-guide dimension mill, a difference is shown in favor of the multiple-guide mill of 1.44 man-hours per 1,000 board feet of dimension stock. Owing to the fact that waste required no sorting when picked for the multiple-guide machine, there was an additional gain of 0.81 man-hour per 1,000 board feet of manufactured stock or a total gain in stock picking and bolting of 2.24 man-hours, which is a decided advantage in favor of the multiple-guide machine.

### RIPSAW METHOD OF CUTTING-DIMENSION STOCK

Another method of reducing waste to smaller sizes is by the use of ripsaws of standard type. Aside from the fact that ripsaws are not so fast as bolters, they are very effective. Ripsaws handle long, wide, thick stock as well as smaller sizes. Some of the modern saws can be adjusted quickly and they do accurate work. There is an advantage, too, in that stock can be cut in such a manner as to keep intact the more desirable portions of the material.

Traveling-bed straight-line ripsaws are designed to turn out a class of product more of factory than sawmill type.

Gang ripsaws are designed for fast conversion of sawmill waste into dimension stock. This type of machine may carry up to 10 saws on a single arbor. Like bolters, they are especially effective in cutting squares, though not particularly economical in the use of material.

### BAND-RESAW METHOD OF CUTTING DIMENSION STOCK

Vertical and horizontal circular or band resaws are seldom found in mills cutting dimension stock from mill waste, but nevertheless they are worth while in some cases. Heavy slabs that will yield a high percentage of flat stock can be reduced effectively by means of resaws. For certain products resaws with single rip or gang ripsaws make combinations that are worth investigating.

### RECORDS OF PRODUCTION COSTS IN THE MANUFACTURE OF DIMENSION STOCK FROM MILL WASTE

The average costs of producing dimension stock from mill waste under normal conditions in the northern hardwoods of the Lake States are shown in the following tabulation. Records obtained in studies at three mills have been used as the basis for the figures. The total production costs at the three mills varied within reasonable limits; namely, $24.69, $28.49, and $29.82 per thousand board feet. The costs of the individual operations or items making up the totals were in some cases very close, and in other cases the range was great

enough to indicate that some methods had considerable advantage over others. Brief discussions of cost items will in some cases serve to bring out the reasons for differences in costs.

COST OF PRODUCING AIR-DRY DIMENSION STOCK FROM MILL WASTE

| Cost items: | Average cost per thousand board feet of dimension stock |
|---|---|
| Stock picking | $2.97 |
| Ripping or bolting | 4.57 |
| Trimming | 2.55 |
| Sorting and bundling | 2.77 |
| Twine or wire | .93 |
| Hauling and piling | 2.36 |
| Hauling, loading, and inspection | 1.12 |
| Raw material (waste) | 4.21 |
| Overhead | 5.25 |
| Total | 26.73 |

### STOCK PICKING

Where sorting for thickness of waste picked from the conveyor is necessary in order that work at the bolter may proceed with no interruption, the expense of stock picking is appreciably increased. The average cost of stock picking at two mills that sorted for thickness was $3.17 per thousand board feet of squares, while the corresponding cost at a third mill where no sorting was necessary was only $2.55.

### BOLTING

Where sorting for thicknesses is required, the cost of bolting is also increased. The average bolting cost at two mills sorting for thickness was $5.18 per thousand board feet of squares. At one of these mills, sorting was not completed at the conveyor, that is, thicknesses over 4/4 were obtained by the bolter crew, and consequently the bolting cost was high. At the mill where no sorting was necessary the cost was $3.39.

These figures indicate an advantage for the type of bolter that requires no sorting of raw material. Naturally, the speed of operation is dependent in large measure on the machine itself, hence all of the difference in speed indicated by the cost figures is not due to difference in sorting methods. The fact that the multiple-guide bolter was equipped with a gang saw and that both the lath-bolter and lath-mill operations were performed by the one machine had much to do with the speed that was developed.

### SORTING AND BUNDLING

The methods of sorting and bundling dimension stock from mill waste are so similar to those required for dimension stock from small logs and from short bolts that they are discussed jointly under the heading "Handling and seasoning of dimension stock," (p. 39). In the records of production costs presented here, the costs for sorting and bundling are combined, for at two of the mills the labor strictly chargeable to each could not be segregated.

The wide spread in costs between the mills where sorting was entirely manual and the mills where it was not, indicates that it is

decidedly worth while to give the matter of sorting more attention than it usually receives. When it is necessary to hunt around for the proper place to deposit each piece the operation costs mount to unreasonable figures.

Sorting and bundling at one mill where the sorting was automatic showed a low cost of $1.75 per thousand board feet, whereas at another plant, where both operations were performed entirely by hand, the cost was $4.35 per thousand board feet. It is necessary to emphasize that such a wide range could occur only when practically the entire product was squares. With a mixture of squares and flat stock, the advantage of an automatic sorter would be greatly reduced. Between the two mills where sorting and bundling were manual there was a difference in cost of $2.13 per thousand board feet. The wide range was due not so much to difference in methods as to speed with which the operation was performed.

### TRIMMING

The differences among the various mills in the time required for trimming were not great. In spite of machine improvements this operation will always require the exercise of considerable judgment in handling of material. It is probable that this is an operation where a few cents extra cost is good economy from the standpoint of saving of material and quality of stock produced. A comparison of costs for this operation shows that at the mill where trimming was partially automatic the costs were largest. In trimming as well as in other operations the size of the material has considerable influence on the cost. At three mills where 1-inch squares comprised 60 to 65 per cent of the total cut of dimension stock the trimming costs were $2.22, $2.61, and $2.81 per thousand board feet. At a fourth mill where 1-inch stock formed but 1 per cent of the cut the trimming cost was only $1.86.

### YARD COSTS

Costs outside the mill, such as hauling, piling, and loading, should not vary greatly from one mill to another but as a matter of fact there are appreciable differences. Hauling with a wagon and team, which is the usual practice, is cheaper than loading the product on cars at the mill and switching it out to be unloaded again at the point where it is to be piled. Hauling is expensive because of the two handlings that are required. Sorting bundles or pieces is necessary either at the mill or where the stock is to be piled. The various sizes must be unloaded at piles of corresponding thicknesses. For these reasons transferring stock from mill to yard is a major item of expense that should be closely watched.

The methods of piling, storing, and inspecting dimension stock manufactured from mill waste are the same as those described for dimension stock manufactured from small logs and from short bolts under the heading "Handling and seasoning of dimension stock," page 39. The cost of piling dimension stock at the mills investigated was $1.42 per thousand board feet. With proper organization it should cost from 25 to 50 per cent less. The operation requires the exercise of little judgment on the part of the workman, and there

is a good opportunity for piecework. The cost of loading on cars for shipment was $1.25 per thousand board feet, where payment was made on an hourly wage basis. Here again is an opportunity for organization or for piecework. Without proper approaches from pile to cars, with conditions such that men obstruct one another, with poor arrangement of piles, and with other factors that interfere with smooth performance loading tends toward unreasonable costs.

### BINDING MATERIAL

A discussion of twine and wire is found on page 42. The amount of twine used varies because of the difference in methods of using it. There is a corresponding variation in cost per thousand board feet of stock. Some mills bind stock twice, once when it is transferred from the mill to the yard and again when it is bundled for shipment. Some mills wrap the binding material about the stock twice at each tie whereas others wrap but once; some put two ties on a bundle, and some three. Careful studies of minimum requirement for twine have not been made, probably for the reason that twine is usually thought of as a cheap material. Observations indicate that there is considerable opportunity for economy in the use of binding material.

### OVERHEAD COSTS

Overhead costs at the mills investigated averaged $5.25, which is a low figure in comparison with the same charge in a mill cutting dimension stock exclusively. With stricter accounting, the overhead costs would be higher than those shown. No charge has been made for the mill space occupied by the dimension departments for the reason that the space was originally provided to house a lath department, the dimension work usually being an afterthought. Supervision is low because it is necessary to charge but a small portion of a foreman's time to directing the dimension-stock operations.

### INSPECTION OF STOCK

The costs of inspecting and loading dimension stock are usually combined. The cost of inspection alone averages approximately 40 cents per thousand board feet. If inspection is done with the thoroughness that the importance of the work justifies (p. 40) the cost is at least twice as great.

### RAW MATERIAL

The average cost of mill waste that will yield a thousand board feet of dimension stock under representative conditions in the hardwoods of the Lake States, is $4.21. This average cost is computed from fuel-wood prices that are typical for the Lake States.

## HANDLING AND SEASONING OF DIMENSION STOCK

### INSPECTION OF STOCK

The manufacture of dimension stock from small logs, short bolts, or mill waste is not complete until a thorough inspection has been given every piece that is to be sent from the mill. Some mills

recognize the importance of good inspection and give it the attention it deserves. With most mills, however, inspection is performed in a perfunctory manner, with the result that much dimension stock reaches the consumer unfit for the use intended. Sawyers, sorters, and others can not be depended upon to throw out the pieces that are not up to a certain quality standard, because with so many different operators there is a wide difference of opinion as to what should be the standard, and as a result one man may cull a piece that another would have passed. The natural tendency is to cull only the pieces that obviously are below grade. Thus, where many inspectors are involved, there is a large quality variation in the dimension stock in a single lot intended for a certain use. Good inspection requires that one qualified man be made responsible for the inspection of all the stock that leaves a dimension-stock mill. An inspector, in order to be competent, must understand the problems of the user, and he must know how dimension stock is handled, machined, and finished in the factory. Without such knowledge an inspector can not appreciate the damaging effects of defects. It is hardly to be expected that the entire crew of a dimension-stock mill will have the training required for inspection.

The common practice in dimension-stock mills is to inspect the stock in the green condition when it first goes through the mill. The stock is then piled in storage for six months or a year for the purpose of drying or until there is demand for it. In the meantime, seasoning defects, such as stain, decay, warping, checking, or the like, may occur. In spite of the degrade likely to occur during storage it is exceptional practice to inspect dimension stock again when it is being loaded for shipment. Inspection just prior to shipment is more essential than inspection at any other time during manufacture, and when properly done eliminates much of the cause for rejection of dimension stock by the consignee.

### DIMENSION-STOCK SPECIFICATIONS

Outstanding among causes of inspection difficulties is the lack of adequate dimension-stock specifications. As a rule each buyer has his own quality standards, and the specifications governing his purchases are based on his specific needs or fancies rather than on the average needs of manufacturers of products of the same type or class as his own. The system leads to endless difficulty and misunderstanding. Moreover, specifications are rarely written with clear, definite detail. Too much is left to the judgment of the operators or inspector.

Good specifications include a statement of the kind of wood, the kind and extent of defects and blemishes permitted, sizes, oversize allowance, price, delivery date, and degree of dryness. The terms "air dry," "kiln dry," or "shipping dry" are too indefinite, and are not legally recognized. The degree of dryness should therefore be stated in terms of the percentage of moisture content that is desired; such as 5 per cent, 8 per cent, 15 per cent, or the like. Special features relating to sapwood, heartwood, flat or quarter sawing, slope of grain, number of annual growth rings per inch, density, and figure should be adequately provided for in the specifications.

Standard specifications for dimension stock are entirely practicable. Uniform specifications for turning squares and for furniture squares and flat stock, have been published in the rule books of the National Hardwood Lumber Association for several years. However, the rules are little used; hence the specifications exist chiefly in name, not in practice. If the rules printed do not serve the purpose intended they may be improved and revised whenever changes are shown to be necessary. They were adopted as a foundation for specifications that eventually would simplify dimension-stock marketing in the same way that lumber standards have simplified lumber marketing. However, until the standards are more generally used and their shortcomings demonstrated, improvement in dimension-stock marketing at best will be slow.

### SORTING AND BUNDLING

The methods of sorting and bundling dimension stock manufactured from small logs, short bolts, and mill waste are practically the same. For an output of 5,000 board feet of dimension stock per day the operations require the time of two men. Sorting of cuttings according to thickness, width, and length is a time-consuming operation and one that has not been worked out with entire satisfaction. Generally, sorting is performed by hand, but sometimes the operation is automatic.

Sorting is accomplished by means of various rack arrangements. Pieces of like size are placed in pigeonholes or compartments until the number required for bundles of different sizes are brought together, after which they are either tied into bundles in place in the racks, or they are removed to some other point and the bundling completed there. Figure 13 illustrates one rack arrangement designed for sorting dimension stock where the tying is done before the bundles are removed from the rack. This arrangement has the advantages of small initial outlay and no subsequent upkeep costs. Its capacity, however, is limited to but a few cutting sizes. There are similar racks where the compartments are arranged vertically one over another instead of horizontally side by side as indicated in Figure 13. The vertical arrangement necessitates tying the bundles after they are removed from the rack.

Automatic sorters (fig. 16) are only partially successful because they sort only for length of one class of stock. Hence, they operate satisfactorily when the dimension stock consists entirely of 1 or 2 inch squares, or some other size, but when different sizes of squares and various widths of flat stock are cut simultaneously, as is usual where the raw material is logs, the automatic sorter of the type shown in Figure 16, must be supplemented by hand sorting.

There is nothing standard about either hand or mechanical sorters. Usually they are built to meet the specific conditions of each mill. Determining factors are the space available, the kind and amount of stock cut, the ingenuity of the mechanics, and the permanency of the operation.

Bundling is employed in most mills in order to reduce the high cost of handling and tallying small stock. No organized effort has been made to standardize the size or type of bundles or the method of building; hence there is a wide range in practices. Bundles of di-

mension stock vary in size from those containing only a few pieces to large sizes that are about as much as a workman can carry.

Table 11 indicates the number of squares of various sizes required to make a bundle containing approximately 10 board feet. From the standpoint of weight and size many producers and users find 10 board feet a convenient unit.

TABLE 11.—*Size of squares and number of pieces required to make a bundle containing approximately 10 board feet*

| Size of square (inches) | Length of square | Pieces in bundle | Board feet in bundle | Size of square (inches) | Length of square | Pieces in bundle | Board feet in bundle |
|---|---|---|---|---|---|---|---|
| | *Inches* | *Number* | *Number* | | *Inches* | *Number* | *Number* |
| ½ | 48 | 120 | 10.00 | 1¾ | 48 | 10 | 10.31 |
| 1 | 48 | 30 | 10.00 | 2 | 48 | 8 | 10.66 |
| 1¼ | 48 | 20 | 10.42 | 2¼ | 48 | 6 | 10.12 |
| 1½ | 48 | 12 | 9.00 | 2½ | 48 | 6 | 12.5 |

Binding material for the bundles is of twine, wire, or metal strapping. Twine tying is done by hand, strapping by machine, and wire tying both by hand and machine. Twine is the binder commonly

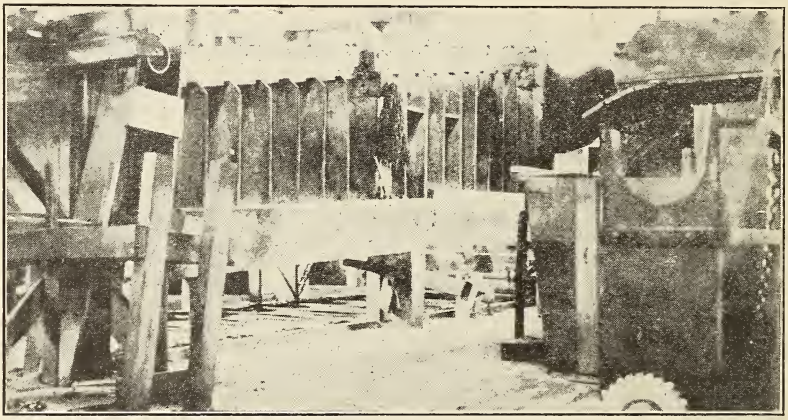

FIGURE 16.—An automatic dimension-stock sorter that permits the grouping of equal-sized squares with a minimum of manual labor. It consists of a series of bins into which the stock drops from the conveyor above. Beyond this stage the operation is manual. Squares are assembled in bundles, twine tied, tallied, and dropped through trapdoors to the outside

used because it is the most flexible, can be easily handled, does not cut edges of stock, and is thought by most operators to be cheaper than the others. Common black annealed iron wire is sometimes objectionable because it rusts when used on green stock that is held in storage for a considerable length of time. Galvanized wire, which will not rust nor discolor stock, is recommended for use with green stock. Metal corner clips are sometimes effectively employed with binding wire in order to keep the wire from cutting into the corners of the stock. Bundling of dimension stock with wire has been developed to a stage where information is available with respect to the proper gage and type of wire required for bundles

of certain sizes or weights and how many ties are needed. There are tying machines and devices of various types, some of which are extremely simple and some of which are complicated. The choice of bundling equipment is a problem that merits considerable study, but fortunately manufacturers of wire-tying equipment are in a position to render valuable assistance.

Figure 17 illustrates one of several types of machines that make very effective ties. Tension on the tire around the bundle is obtained mechanically.

The simplest device now used for wire tying is a metal hand grip about 6 inches long through which a wire is threaded. The interior of the grip contains a clutch arrangement that can me manipulated so as to permit the wire to slip whenever the operator desires. With this device, tension on the wire is accomplished entirely by hand; hence the quality of the tie and the compactness of the bundle depend entirely upon the operator. The device simply furnishes a means by which the wire can be gripped by the workman as he pulls it taut about the bundle, ties it, and breaks it at a kink close to the tie.

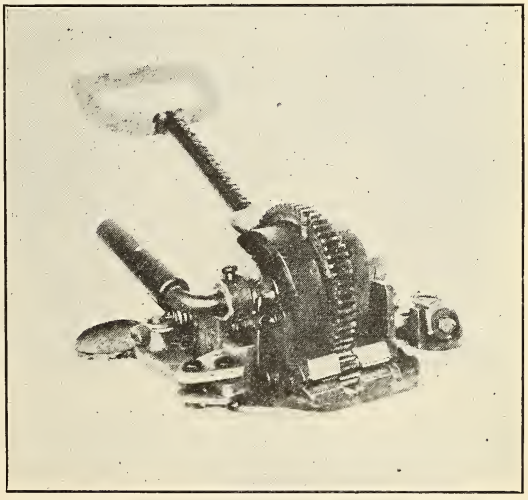

FIGURE 17.—A tying machine that operates successfully on small bundles of dimension stock. It employs 16½ and 17½ gage high tensile or ordinary annealed wire

Bundling costs are usually too high because sufficient effort has not been made to develop cheap methods. Many producers of dimension stock take it for granted that twine is a cheaper binding material than wire and that the total bundling costs are in favor of twine. As a matter of fact, a careful investigation shows that for most types of bundling of rough dimension stock, wire is cheaper and more satisfactory than twine. Twine at 18 cents per pound resulted in a binder cost of 84 cents per thousand board feet of dimension stock, whereas 16-gage black annealed iron wire at 5 cents per pound resulted in a cost of 53 cents per thousand board feet. The investigation disclosed several instances where twine was employed at costs in excess of $1.25 per thousand board feet.

Bundling methods vary with the weight and length of the bundles. The following schedule, although not so convenient as that given in Table 3, is a common one: Regardless of length, 1-inch squares are tied in bundles of 25 pieces; 1¼-inch squares, 16 to the bundle; and 1½-inch squares, 16 to the bundle. Two-inch squares, 30 inches long, are tied with 9 pieces to the bundle. Two-inch squares over 30 inches long usually are not bundled. Bundles up to 36 inches long usually have a tie at each end. Bundles over 36 inches long

usually have an additional tie in the middle. Occasionally when bundling is for temporary purposes stock under 12 inches long has only one tie in the middle. When wire is used it is possible to make secure bundles up to 18 inches long with one tie about the middle. Twine of one strand is ordinarily considered strong enough. Twine of two strands is sometimes used for heavy bundles.

Flat dimension stock is also bundled, but there are no methods as firmly fixed as for squares. The chief guide to size and form is convenience in handling. In some cases buyers specify the number of pieces bundles shall contain but usually the matter of size is optional with the shipper.

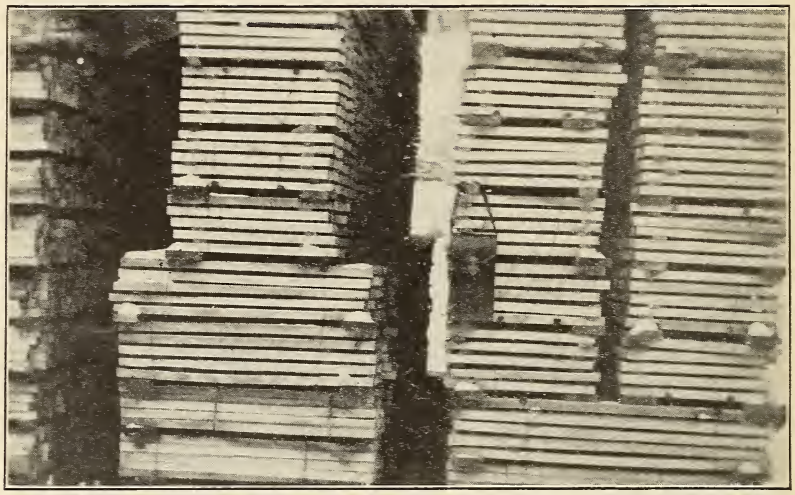

FIGURE 18.—Bundling with stickers between courses in the bundle has been found impractical. Wire-tied bundles with stickers between courses and with metal corner clips to prevent cutting by wire are shown in the upper right and central portion of the picture. Twine-tied bundles are shown on the extreme left and also in the lower portion of the picture. Considerable bowing of pieces between stickers in the bundles may be noted

For stock intended for immediate shipment and use it has been found practical to make wire-bound bundles of quite another type. The following schedule is illustrative of the scale used:

1-inch squares, 24 inches long, 126 pieces to the bundle.
1½-inch squares, 24 inches long, 70 pieces to the bundle.
2½-inch squares, 30 inches long, 35 pieces to the bundle.
1-inch flat stock, 3 inches and wider, 16½ and 18 inches long (chair-seat stock) about 16 board feet to the bundle.

Bundles of the foregoing sizes reduce the number of binding operations as well as the subsequent handling expense. Such bundles on account of their size and weight should be bound with wire.

During the past few years considerable trial has been given to the method of placing small stickers (fig. 18) between courses in the bundles. The stickers have in some cases been ¼-inch squares and in other cases sections of lath. The objective in this method of bundling is to secure circulation of air through the bundle and thus accelerate drying and at the same time prevent stain. To date no successful methods of constructing and handling stickered bundles

have been developed. Difficulties, such as added expense, warping of pieces between stickers, and loosening of bundles with the accompanying loss of stickers when handled after a period of drying, have led those attempting the practice to give it up as impractical. Another objection to the practice is that greater storage and shipping space is required for the stickered bundles.

### PILING AND STORAGE OF DIMENSION STOCK

Recent years have brought noteworthy improvement in methods of caring for dimension stock. It is universally recognized that there is no consistency in a method where stock is carefully manufactured and then piled carelessly on the yard without protection from the weather. Storage methods that are satisfactory for lumber may be ruinous for dimension stock. Good drying sheds are now common. Where dimension stock is not stored in sheds it is usually placed on substantial foundations and is well covered. Frequently the ends and sides of piles of dimension stock are also covered as a measure of protection from sun and wind.

Lumber-piling methods have been well standardized but not dimension-stock piling methods. Dimension-stock piles are frequently put up in what appears to be the most convenient way without regard to the effect on the stock. The most damaging results have come from close-piling bundled stock. This method is rapid but generally unsatisfactory. Other common mistakes have been insufficient number of stickers between bundles, poor alignment of stickers, piles excessively open, too close piling, poor or low foundations, and instability of piles.

Systematic arrangement of piles will improve conditions at most operations. As far as possible stock of the same dimensions should be piled together and not wherever there happens to be a vacant space. Good arrangement of the bundles in the pile facilitates piling and loading and also simplifies invoicing.

The approximate date of piling each lot of stock should be recorded. Good records enable decisions with respect to the advantages of certain types of piling, since from them it is possible to determine the rate of drying. Furthermore, good records relieve unskilled workmen of the responsibility of deciding whether dimension stock is dry enough to meet shipping specifications. Owing to lack of sufficient records, cars loaded for shipment frequently contain dimension stock varying in moisture content from thoroughly air dry (12 to 15 per cent moisture) to practically green.

Men who are accustomed to piling lumber do not take readily to handling individual pieces of dimension stock; hence their efforts are not always effective. Dimension-stock piling can be done quickly and well only after considerable practice. The mistake is generally made of changing piling crews whenever it seems convenient to do so. The result is not only a decreased rate of piling but also poorer piling. Men who are kept piling small stock continuously develop a certain knack and system that is noticeably lacking in those whose entire experience has consisted of piling long, wide lumber. The most efficient piling is in the Northeastern States, where the workmen have grown up in the dimension-stock business. Dimension stock can be piled satisfactorily and the cost can be reduced to a reasonable

figure. In one instance in the Lake States the transferring and piling of stock on the yard cost $2.29 per thousand board feet. Transferring from the yard and piling in the car for shipment cost $2.05 per thousand board feet. Obviously such costs are unreasonably high. They indicate that there is something seriously wrong with the handling and piling system. The trouble in this particular case was too many unskilled men on the job, which resulted in too much lost time and motion.

Where the volume is great enough to demand the time of one or more men, the piling of dimension stock can profitably be put on a piecework basis. In some cases it might be advisable to use a piece basis even where less than one man's time is required for piling. If there are other jobs about the mill on which a man's time could be spent on an hourly basis, there might be an incentive to speed up the piling and spend as much time as possible on the other work. Loading on cars is chiefly a matter of speed in getting the stock in the cars. Care in piling or arrangement of material in the car is a minor consideration as the stock remains in transit only a short time.

### CONVEYORS

The high cost of handling numerous small pieces has been overcome in many businesses by the use of conveyors and in some instances conveyors can be used to advantage in handling dimension stock.

Gravity conveyors with rollers closely centered can be arranged to handle dimension stock of any size. A conveyor will operate on a fall of one-half to five-eighths inch per lineal foot. A conveyor 6 feet high at the mill end will convey stock about 100 feet. By means of a power lift operated by a ⅛-horsepower motor placed at the end of the first 100 feet, dimension stock can be cheaply elevated 6 or 8 feet and dropped into a second conveyor unit 100 feet or more long. A conveyor of this type will cost about $3 per lineal foot. The conveyor may run alongside the storage or dry shed so that the dimension stock can be discharged wherever most convenient for piling. In such an event, the conveyor would replace part time of a team, teamster, and three or four men.

It should be recognized, however, that the use of conveyors may be overdone. Occasionally there is temptation to load up with labor-saving devices to an extent that renders the manufacturing system top-heavy. Machinery costs money whether it is working or not, while day-labor costs cease the minute the plant ceases operating. Every move to displace labor with machinery should be carefully studied on a long-term basis.

### SEASONING

Dimension stock manufactured from small logs, short bolts, or mill waste should not be dried by the same methods used in drying lumber. This applies both to air and kiln drying.

The troubles encountered in drying lumber are magnified when small pieces are substituted. The tendency to warp, twist, and check, increases as the size decreases, as do also the handling costs.

(Fig. 19.) Certain species and certain sizes, however, are less troublesome to dry than others. With a knowledge of the items to avoid or to treat with special care, drying failures can be minimized.

Only a limited amount of experimental work has been done on dimension-stock drying, but, on the basis of information resulting from test runs at the Forest Products Laboratory and that accumulated from observation of commercial drying, it is possible to set down a few broad guides to sizes of stock or species with which good success may be anticipated when drying stock green from the saw.

(1) Maple, paper birch, yellow birch, basswood, and aspen squares 1½ inches and over in thickness and up to 48 inches in length can be dried to 6 or 8 per cent moisture content with losses not exceeding 10 per cent.

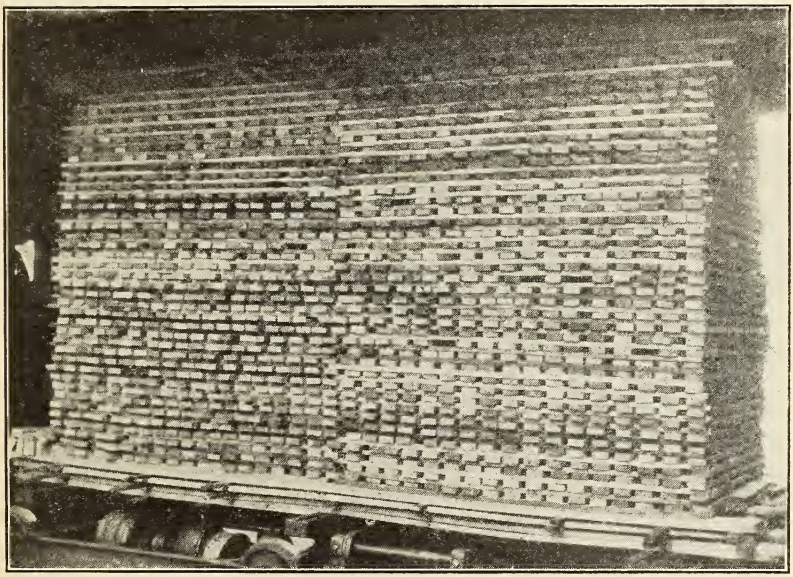

FIGURE 19.—Piling dimension stock on trucks for kiln-drying involves the handling and precise placing of many pieces having small volume. Speed, proficiency, and reasonable costs are attained with practice

(2) Maple, paper birch, yellow birch, basswood, and aspen flat stock 4/4, 5/4, and 6/4 inches thick, 3 to 7 inches wide and up to 30 inches in length can be dried to 6 or 8 per cent moisture content without excessive degrade.

(3) Flat stock from 2 to 2½ inches thick, 3 to 10 inches wide and up to 4 feet in length can be dried to 6 or 8 per cent moisture content without difficulty.

(4) One-inch maple, paper birch, yellow birch, basswood, and aspen squares up to 18 inches in length can be successfully dried to 6 or 8 per cent moisture content, but squares in excess of 18 inches in length require exceptional care to prevent warping.

Experience has shown that a few precautionary measures will materially reduce kiln-drying difficulties.

(1) With dimension-stock squares of small cross section, the use of stickers to reduce the length of the unsupported sections aids considerably in preventing bowing and twisting in drying.

(2) The ends of all pieces of dimension stock should rest on stickers.

(3) Different thicknesses or species of squares or flat stock should not be mixed in the same kiln load.

(4) The top course of a load of dimension stock should not be left exposed while in the kiln. Weighting down the dimension-stock piles with lumber tends to prevent the upper courses from warping.

(5) End coating effectively reduces end checking.

Kiln-drying dimension stock that is green from the saw has not been attempted on a large scale. Generally, stock is air-dried for some time before it is given final drying in a kiln. Operators report that where dimension stock has been partially air-dried the degrade in kiln drying is about 5 per cent.

Kiln-drying stock that is green from the saw would eliminate the preliminary piling for air-drying as well as the holding of the stock in the yard for several months, which results in a heavy investment charge. On the other hand, partial air-drying may be more profitable where steam for operating dry kilns is expensive. Moreover, the moderate rate at which stock is air-dried in the initial stages lessens the tendency for it to develop drying defects, especially where kilns are inefficiently operated.

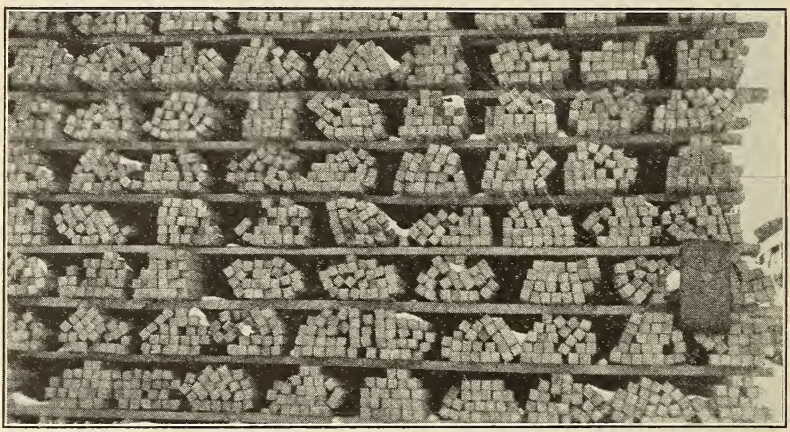

FIGURE 20.—Loose twine-tied bundles of dimension stock piled for air seasoning. The loose stock dries rapidly and with less stain than in solid, tight bundles, but at a sacrifice of straightness in many unsupported pieces

Kiln drying of dimension stock at the source of production is a practice that is increasing. Many producers are now equipped to kiln-dry and furnish stock dried to a specified moisture content. Fundamentally this system is sound, for the shipping weight of dimension stock is greatly reduced thereby. Furthermore, it is more economical to dry stock at mills than at factories that are on sites of high valuation in congested districts.

Dry-kiln operation is not economical for a plant with an output so small that the kiln-drying cost exceeds about $12 per thousand board feet for 1-inch stock. There is no generally accepted idea of what constitutes the most satisfactory type of kiln for the medium to small dimension-stock mill.

Air-drying dimension stock satisfactorily requires special methods. Dimension stock that is piled in the yard as lumber and given little protection from the weather depreciates to such an extent that a large part of it is unsuitable for the purpose intended. The

most serious defects developed in improper air seasoning are weather staining and surface and end checks. The percentage of degrade in pieces on the outside of the pile is especially high. Squares in bundles have been frequently piled on the yard for air-drying. (Fig. 20.) Usually the result has been badly molded and stained stock that is suitable only for firewood.

Fortunately there has been a notable change in the practice of air seasoning dimension stock in the last two or three years. The increased attention given to better lumber-drying methods is gradually sifting through to dimension stock. Many drying sheds have been constructed for dimension stock that make possible rapid drying and at the same time give the necessary protection from rain, sun, and snow. Figure 21 shows a typical shed built specifically for

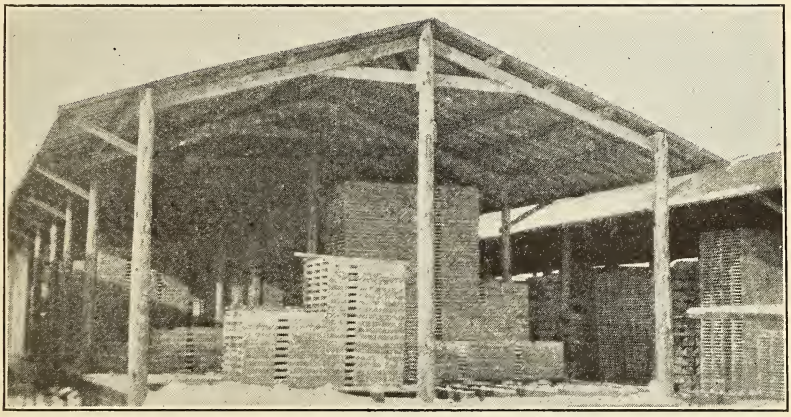

FIGURE 21.—Air-drying in well-constructed sheds yields dimension stock of a quality necessary for the consumer's needs. Shed roofs must be water-tight, foundations and pile footings must be open yet solid and unyielding

dimension stock drying. The following essential features may be noted:

(1) Water-tight roof with wide overhang to prevent moisture dripping on to stock and to prevent entrance of the hot midday sun; (2) open construction to give maximum of ventilation; (3) high foundation to keep stock away from ground moisture and to allow air circulation under piles; (4) sturdy, nonsagging stringers and crossers to avoid settling and leaning piles; (5) high posts to provide maximum practical capacity under one roof.

The type of piling which is shown in Figure 22 is an example of poor piling. The intervals between the air chimneys are too great to insure perfect circulation of air on the interior of piles. Owing to lack of proper air circulation in hot weather, small stock piled in the manner illustrated will stain.

Figure 23 presents a good example of dimension stock lap piled. The lapping is uniform, the ends are well protected by projecting stickers, and the foundation is high and solid.

Figure 24 illustrates the type of piling once common but now giving way to improved methods that result in better stock. The dimension stock shown was badly weathered and stained. The stain penetrated in the surface checks considerably deeper than the portion

that would be removed in dressing the stock to standard thickness. End checks, warp, and crook were excessive.

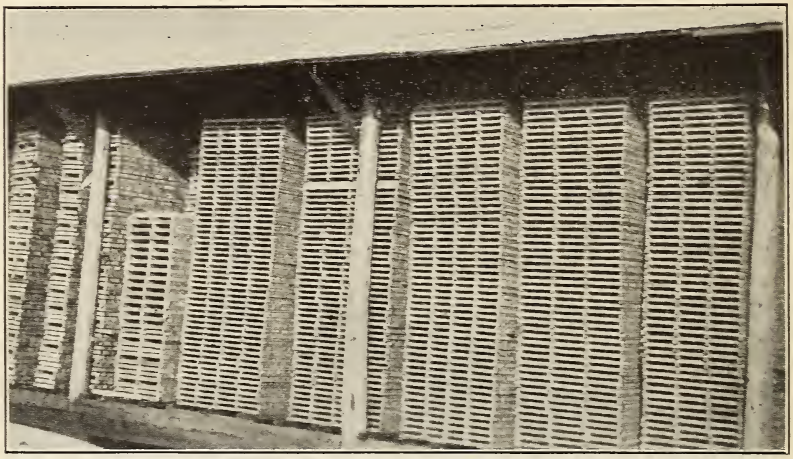

FIGURE 22.—An example of careful but faulty methods of piling dimension stock. The piles at the left, although neatly piled, alternate lath-stickering with self-stickering. Lath stickers are too thin to permit good air circulation, and staining results. The piles on the right are self-stickered, but the circulation chimneys are too few

Adequate protection should be furnished all stock that is piled in the open. One mill in the Lake States cuts bolts into flitches, piles the flitches for air-drying with the barky edges exposed to the weather (figs. 25 and 26), later kiln-dries the air-dry flitches, and finally rips the kiln-dry flitches into squares.

FIGURE 23.—Flat dimension stock lap piled for air-drying. The method assures a maximum drying rate, and at the same time pieces are well enough supported at the ends to reduce warping. In some species fast drying will increase the tendency to end and surface check.

Figure 27 illustrates material piled in the open with proper regard for its value. The pile is well roofed, the roofing extending out far enough on all sides to prevent moisture dripping on the stock below. Ends are well protected by stickers that project for the purpose of reducing end checking. Adequate use of stickers carefully placed in straight vertical lines supplies support that tends to prevent warping.

The degree of success to be had in drying dimension stock in bundles is largely determined by the kind of bundles, size of stock, manner of piling, whether the stock is piled in sheds or in the open, and by the location of the storage yard with reference to exposure to

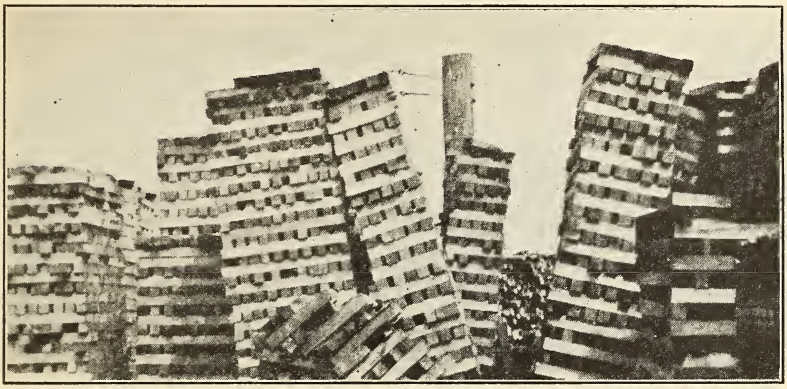

FIGURE 24.—Piling in the open with no protection from sun, rain, and snow results in excessive warping, checking, and weather staining. Stock carefully manufactured in the mill is quickly ruined by careless yard methods

sun and wind. The moisture content of bundled stock a year after cutting may be as high as 25 per cent or more. The air-drying of dimension stock in bundles is therefore not to be recommended unless circumstances are exceptional.

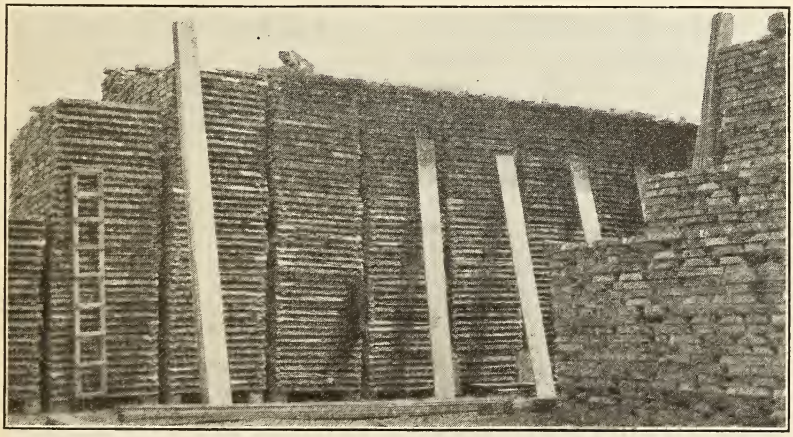

FIGURE 25.—End checking in heavy maple stock can be reduced with proper piling. The picture shows flitches, with the barky edges exposed to the weather, piled for air-drying. The flitches are well spaced, carefully stickered, and rest upon substantial foundations

## END COATING

End checking is one of the most serious defects in drying dimension stock. Some species check more than others but in none is this tendency so slight that it is not a cause for considerable concern. Methods of piling, thickness of stock, temperatures, and other fac-

tors have an influence on the extent of checking, and a fair measure of control is possible by the use of proper methods. End coatings prevent the rapid escape of moisture through the end surfaces of the stock and consequently retard surface shrinkage and checking.

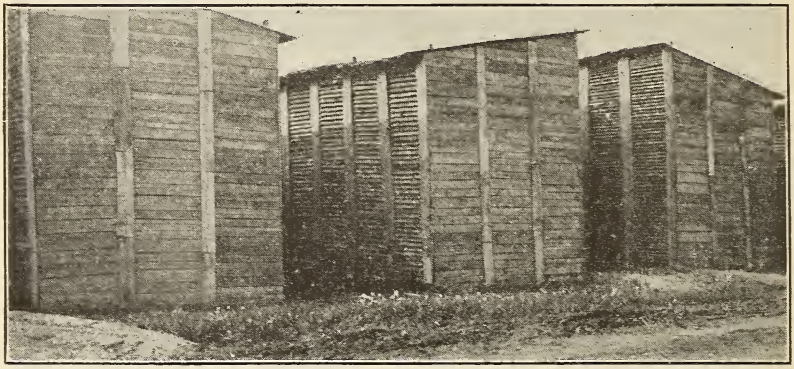

FIGURE 26.—In addition to the careful piling shown in Figure 25, boards have been placed over the butt joints in the piles to retard circulation and thus reduce checking in fast-drying weather. The stacks are well roofed and boarded on the sides exposed to the sun

End coatings are of various kinds and degrees of effectiveness. The more impervious to moisture they are the greater their ability to prevent checking. End coatings may be ordinary paint or heavier materials, such as paraffin or preparations containing rosin.

End coatings that are properly applied give satisfaction. End coatings in some instances have caused complaint from machine

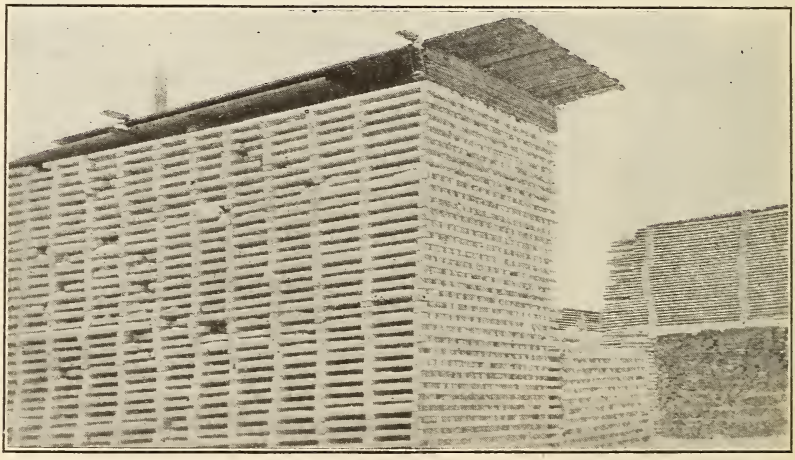

FIGURE 27.—Flat dimension stock well piled in the open for air-drying. Good roofing, well-protected ends, good stickering, and ample space for air circulation provides optimum conditions for stock that when dry will be white and straight

operators in factories who have had the beds of their planers and other machine parts gummed by the coatings to an extent that has hindered normal action. In such cases it has been not so much the fault of the coating as the careless method of its application. Un-

less the coating is applied with some degree of care there is a tendency to coat the sides of some of the pieces one-half inch or more from the ends. When such improperly coated stock is run through a planer some of the coating is deposited on the planer bed and other parts of the machine.

A series of measurements made at the Forest Products Laboratory to determine the effectiveness of end coatings gave the following results:

Out of 289 pieces of end-coated, kiln-dried maple from 9/4 to 12/4 inches thick, 30 pieces or 10.4 per cent were end checked. The average total length of check per piece was 4.9 inches.

Of 50 pieces of maple of 9/4 inch thickness that were not end coated, 48 pieces, or 96 per cent, were end checked; the average total length of check per piece was 10.6 inches. In this group the average length of the individual check was 2.6 inches.

The effectiveness of end coating has been thoroughly proved in the seasoning of dogwood and persimmon dimension-stock squares intended for shuttle stock, in high-grade maple used for quality turnings, in walnut gunstock blanks, and in walnut and mahogany squares and flat stock used in furniture.

Hardened gloss oil, one of the effective coatings developed at the Forest Products Laboratory, is prepared according to the following formula:

The oil itself should be of a thick grade, made up (by the paint manufacturer) of about 8 parts by weight of quicklime, 100 parts of rosin, and 57.5 parts of spirit. To 100 parts of the gloss oil add 25 parts of barytes and 25 parts of asbestine. One or two parts of lampblack may also be added if a black coating is desired.

The asbestine helps to prevent the settling out of the pigment. Any paint manufacturer can make up this coating. It can also be mixed by the user as needed, if the proper grade of gloss oil is obtained. Some of the gloss oils on the market have little moisture resistance. It is essential, therefore, that the coating be made up in accordance with the foregoing formula.

Best results are secured if the coating into which the ends of the pieces are dipped is placed in a wide, shallow container and is about one-eighth inch deep.

## PRODUCTION AND MARKETING COSTS

### COMPARISON OF COSTS OF PRODUCING DIMENSION STOCK BY DIFFERENT METHODS

Production costs are, of course, affected by wage rates. In order that an operator who contemplates manufacturing dimension stock may adjust the cost figures given in this circular to the current wages at his mill, the average rates of pay per hour for various types of mill work existing during the period when the studies were conducted are given in the following schedule: Deck man $0.40, sawyer $0.45, carriage man $0.375, tail sawyer, $0.325, common mill hand, $0.325, stock picker $0.35, lath bolter man $0.375, trimmer man $0.35, sorter $0.35, bundler $0.35, teamster $0.325, yardman $0.335, piler $0.35, loader $0.335, inspector $0.45, foreman, $0.585.

Comparisons of the production costs of dimension stock manufactured from small logs, short bolts, and mill waste are of doubtful

value. Unless other related factors are taken into consideration comparisons are liable to be more misleading and confusing than helpful. For example, the following tabulation, which gives the results of special studies made where different forms of raw material were used, indicates that dimension stock can be cut from mill waste far more cheaply than from bolts or small logs. Bolts and logs, however, yield larger and more valuable stock. Roughly speaking, stock cut from mill waste has an average market value of $49 per thousand board feet, whereas stock from small logs has a value of $55 per thousand board feet, a difference of $6. Moreover, the market demand is more likely to be greater for the larger stock from logs and bolts than for the small squares usually cut from mill waste. The operator manufacturing dimension stock from logs and bolts can fill a wide variety of orders, whereas the mill-waste operator is limited in the orders that he can accept. Thus the apparent advantages of using mill waste for dimension stock are in some respects offset by factors which favor small logs and short bolts.

PRODUCTION COST OF AIR-DRY DIMENSION STOCK

| | |
|---|---|
| From bolts | $47.29 |
| From small logs | 41.53 |
| From mill waste | 26.73 |

The difference in cost of raw material accounts for the great spread in production costs given. The cost of logs required to yield a thousand board feet of dimension stock has been shown to be $14.32 (p. 16). The corresponding figure for mill waste is $4.21 (p. 37), the difference being therefore $10.11 in favor of the stock from mill waste. Observations at many mills manufacturing dimension stock from mill waste indicate that a part of this difference might well be spent in improving the quality of stock through better cutting methods, better seasoning practices, or more rigid inspection.

## COST-FINDING METHODS

In spite of the fact that cost finding is an important phase of dimension-stock production and marketing it is exceptional when adequate cost records are kept, and it is not unusual to find that there are no records and that the balance sheet at the end of the year is the only method of determining whether there has been profit or loss. Under such conditions a dimension-stock business is a mere gamble. On the other hand, extreme refinement and detail in cost accounting tend to make a cost-accounting system so laborious that it defeats the purpose it is supposed to serve. A system that is simple and approximate and that can be maintained at small cost is better than one that is more accurate but too burdensome and complicated to be practical for the average millman who does not maintain a full-fledged cost-finding department.

Although no attempt is made in this circular to give details of various methods of cost keeping, the following essentials of a workable cost-accounting system for dimension-stock production and marketing are presented as a guide.

### COST CLASSIFICATION

The broad classes of costs entering into the total cost of any product are: (1) Raw or direct material cost; (2) direct or productive-labor cost; (3) overhead or burden cost. In turn each of these items is composed of a number of subdivisions. Accounting is considerably simplified if each item of cost is placed in the class in which it properly belongs.

#### RAW MATERIAL COST

Ordinarily the raw-material cost may be assumed to be the cost of the logs, bolts, tie siding, mill waste, or other form of rough material laid down at the mill; that is, unloaded in the log pond, decked, or piled near the mill. With logs it may be the cost per thousand board feet delivered at the mill, or it may be the stumpage plus the logging and delivery costs. In any event the cost of raw material should include every item of cost incurred in connection with getting the raw material delivered to the starting point in the mill operation.

#### DIRECT-LABOR COST

This item includes the actual time of the men spent directly on some phase of preparation of the product from the point where raw-material cost ceased up to and including loading for shipment; for instance, ripsawing, bundling, and loading. It is preferable to keep the cost of the different items separate; that is, head-sawing, ripsawing, and the like. By thus keeping each item by itself one can better judge where costs are seemingly high and can set about systematic reduction. Frequent checks of the costs of individual operations are essential in any well-regulated plan.

#### OVERHEAD COST

Even where some attempt is made to keep costs it is usually in the cost of overhead that irregularities and inaccuracies are most liable to creep in. Generally, many small items are overlooked, the aggregate of which may be an amount sufficiently large to be a serious omission. Overhead costs include the multitude of items that can not be classed with direct material and direct labor. The most common items of overhead appear in the following list:

Interest on investment in land, mill, dry sheds, and equipment; interest on borrowed money used as working capital; lease of land; insurance on plant and cut stock; depreciation on plant; workmen's compensation; taxes on plant, logs, and sawed stock; light and power, including fuel; maintenance of plant and equipment, including new saws, new belting, and general supplies; saw filing, general millwright work, oil and oiling, waste; foreman and general supervision; fireman and watchman; general yard work; office and sales work; advertising.

The list of overhead-cost items may appear rather long and complicated, but actually the different accounts are easily kept when once the proper forms and system of entering charges are designed.

## OVERHEAD-COST DISTRIBUTION

Of the several ways in which overhead distribution may be effected two are particularly well suited to dimension-stock cost accounting. Method 1, which is described in the following paragraph, was used in the studies on which this circular is based.

Method 1 is a fixed-charge method. It takes the total overhead cost for some period and divides it by the production in thousands of board feet for the same period. This gives the dollars per thousand board feet that must be charged for overhead. For example, if the annual overhead items total $10,500, and if the average daily output of dimension stock is 5,000 board feet or 1,500,000 board feet per 300-day year, then $10,500 divided by 1,500 equals $7, or the overhead charge that must be added to the raw material and direct labor costs for each thousand board feet of stock produced. Thus if the raw material costs $20, and if the direct labor costs $13, and if the overhead costs $7, then the total cost of producing and marketing each thousand board feet of stock would be the sum of the three, or $40.

Method 2 is a fluctuating-charge method. It takes the total overhead cost for a certain period and divides it by the number of direct labor hours put in by the men in the mill to get the overhead charge on a per man-hour basis. For example, assume again that the total average annual overhead charge is $10,500. On a 300 working-day year basis the overhead would amount to $10,500 divided by 300 or $35 per day. Assuming that the mill crew put in 87½ man hours per day the overhead cost per man-hour would be $35 divided by 87½ or 40 cents. Thus, for each hour each man would spend on a job there would be a 40-cent overhead charge.

Methods 1 and 2 are equally simple, easily understood, and easily applied. Method 2 has an advantage in that it is possible to get more accurate costs on a certain job or lot. Production costs naturally vary with species, size of logs, and size of stock; hence, it may sometimes be desirable to determine accurately the cost per thousand board feet. Under method 1 all stock is given the same overhead charge per thousand board feet when, as a matter of fact, the actual charge for a particular lot may be considerably higher or lower than the average. In the examples used to illustrate methods 1 and 2 the overhead amounts to 40 cents per man hour, and it requires 17½ man hours to produce a thousand feet of stock. Under method 1 even though some particular lot should require 25 hours the overhead would remain the same, namely, $7 per thousand board feet, whereas under method 2 the overhead would rise from $7 per thousand board feet to $10 (25 x $0.40). To apply method 2, it is necessary to keep a time record for each job—an unusual practice for small mills.

Ordinarily a fixed overhead charge is sufficiently accurate for sawmill work where the form and quality of raw materials and operating conditions do not vary much from time to time. However, where more accurate detailed costs are desired on some particular job the fluctuating-charge method is preferable.

### COST KEEPING FOR DIMENSION STOCK FROM MILL WASTE

It has been quite general for producers of dimension stock from mill waste to figure that the waste going into dimension stock has no value. In exceptional cases this may be correct, but usually it has at least a value equivalent to its value as fuel wood. Failure to assign a value to the material introduces a large error that tends toward establishing market prices that are ruinously low, not only for the manufacturer who miscalculates, but also for his competitors, who are obliged to meet the market prices.

The determination of the cost of material on the basis of its value as fuel wood is a simple matter. It is necessary only to take a cord or some other known quantity of slabs, edgings, and trimmings, weigh it, cut the dimension stock from it, weigh the dimension stock, and calculate the contents of the dimension stock in board feet. From this is determined, first, the number of cords necessary to yield a thousand board feet of dimension, and next the gross value of the raw material in the form of fuel wood. Only a fraction of the average run of mill waste picked from the conveyor for reworking, however, actually goes into dimension stock. Hence, the waste should be credited only with the actual weight of the material in the manufactured stock.

Tests made in the above manner have shown the material in a thousand board feet of dimension stock to be worth about $4. However, this figure applies only to that portion of the Lake States where slab wood has a sale value at the mill of about $4.75 a cord. Fuel prices vary greatly in different parts of the Lake States. A mill near a large inland community may enjoy high prices for mill waste whereas a mill in a small community in proximity to timber may have difficulty in disposing of waste at any price. Consequently, it is necessary for each mill to work out its own costs.

Direct costs, such as bolting, trimming, and sorting, are easily determined, but complications arise when an attempt is made to work out correct indirect costs. The main difficulty lies in the fact that most of the overhead items are operative whether or not waste is cut up into dimension stock. For instance, interest on capital invested in housing and equipment may not increase with dimension-stock manufacture; supervision and office expense are not increased to a measurable degree; and power and light costs are not appreciably increased. Nevertheless, dimension stock from mill waste does not wholly escape overhead costs, for some items are clearly chargeable to it. Insurance and taxes on dry sheds, likewise on manufactured stock, interest on investment, depreciation, and maintenance of dry-sheds and equipment, new saws, files, belting, oil, and other expenses form the indirect costs of producing dimension stock. It is false accounting if dimension stock is not charged with every cost for which it is responsible.

### COST KEEPING FOR DIMENSION STOCK FROM SMALL LOGS

Computing the cost of logs going into dimension stock is complicated by the difference between log and lumber scale. Usually a thousand feet of logs will yield more or less than a thousand feet

of dimension stock. Hence, log values must be adjusted according to the percentage of underrun or overrun. If the overrun is 10 per cent, that is, 1,000 feet of logs yields 1,100 feet of stock, and the delivered cost of logs is $20 per thousand board feet, the cost of logs required to yield 1,000 feet of stock is only $20÷1.100 or $18.18. On the other hand, if logs cost $20 per thousand board feet delivered and there is an underrun of 10 per cent, the cost of logs per thousand board feet of stock amounts to $20÷0.900 or $22.22.

Where small logs are cut into dimension stock as an operation rather incidental to a lumber-mill operation there is some danger that the dimension stock may not be charged with its full share of supervision, investment, and other overhead charges. As with dimension stock from mill waste, there is a tendency to throw too large a burden on lumber for the reason that it is the primary product.

## RELATION BETWEEN DIMENSION-STOCK PRODUCTION COSTS AND SELLING PRICES

The logical method of procedure in establishing the selling price of a commodity is to determine the cost of production and add to it a fair margin for profit. With dimension stock this method is possible only to the extent that the production cost applies to the aggregate volume of all the sizes being cut. Hence, if only one size of stock is being cut it is a simple matter to determine the cost per thousand board feet for producing that particular size. On the other hand, if there are numerous different sizes being cut simultaneously from the same lot of material, that is, 1-inch squares 24 inches long alternating with 1 by 1 by 48, 2 by 2 by 16, 1 by 4 by 21 inches, etc., the problem becomes extremely complicated—in fact, there is no practical method of determining the cost of cutting the individual sizes. In general, it costs more to cut small cuttings than large, and on this basis the large sizes should sell for less. However, clear material in large sizes is more valuable than in small sizes. Thus the factors are so involved that it becomes necessary to assign a single material value per thousand board feet, regardless of the size of the pieces, and also a single labor and overhead figure per thousand board feet, regardless of size of stock. Selling prices for dimension stock increase with increase in size of pieces. However, the increases are arbitrary ones. They are established by supply and demand instead of being based on actual productions costs. Although a mill may show a fair average profit on all sizes, it is probable that some sizes are being sold below actual costs of production. It is safe to say that small squares, of which there is a large supply at low prices, frequently do not return production costs.

## DIMENSION-STOCK MARKETING

Observations indicate that the most successful dimension-stock operators are those who have worked out their selling problems first and then have planned their manufacturing methods.

Dimension stock, like lumber, is marketed by the producer direct to the consumer or through wholesalers. Unlike lumber, however,

it is seldom if ever retailed. In order to sell direct it is usually necessary for a producer to maintain a sales organization. Hence, this form of distribution is more or less confined to larger producers of dimension stock. Small producers, on the other hand, may obtain effective marketing service through wholesalers, who usually have a wide knowledge of market demands. Frequently consumers prefer to deal with dependable wholesalers who have a number of sources of supply to call on than to deal direct with dimension-stock mills of small capacity.

### COOPERATIVE MARKETING

Cooperative marketing of products has some advantages that might be enjoyed by operators of small dimension-stock mills. Pooling of efforts and products helps to overcome obstacles with which the individual mill man can not successfully cope. Large volume and diversity of product makes possible forceful sales effort, uniform inspection, and tends to eliminate extreme price fluctuations. Cooperative arrangements for marketing dimension stock present many obstacles, but they are not insurmountable.

### BALANCED ORDERS

Marketing of miscellaneous sizes of stock of various species is a hazardous undertaking unless specific orders for such stock have been received in advance of manufacture. Under present conditions the only safe way is to arrange marketing details, species, specifications, sizes, and prices and then proceed to fill the orders. Another precautionary measure is to see that orders consist of a proportion of small and large sizes that will enable economical use of raw material in the mill. An example of a well-balanced carload actually shipped to a chair factory is shown in Table 12.

TABLE 12.—*Typical carload of chair stock*

| Number of bundles | Pieces per bundle | Size of stock | | | Volume | Use |
|---|---|---|---|---|---|---|
| | | Thickness | Width | Length | | |
| | *Number* | *Inches* | *Inches* | *Inches* | *Board feet* | |
| 230 | 1 | 1 | 3 and up. | 16 | 2,862 | Seat stock. |
| 10 | 1 | 1 | 4½ and up. | 19 | 127 | Do. |
| 110 | 60 | 1 | 1 | 19½ | 894 | Stretchers. |
| 110 | 60 | 1 | 1 | 21½ | 985 | Do. |
| 384 | 36 | 1¼ | 1¼ | 15½ | 2,325 | Do. |
| 226 | 25 | 1½ | 1½ | 19½ | 1,722 | Do. |
| 16 | 12 | 1 | 6¼ | 30 | 250 | Top slats. |
| 20 | 12 | 1 | 4½ | 30 | 225 | Do. |
| 14 | 12 | 1 | 6¼ | 20½ | 149 | Do. |
| 26 | 12 | 1 | 4½ | 20½ | 200 | Do. |
| 15 | 12 | 1 | 3 | 20 | 75 | Banisters. |
| 22 | 12 | 1 | 4 | 20 | 147 | Do. |
| 18 | 12 | 1 | 3½ | 21 | 110 | Do. |
| 6 | 12 | 1 | 4 | 21 | 42 | Do. |
| 3 | 60 | 1 | 1 | 54 | 68 | Bows. |

An order similar to that given in Table 12 is chiefly advantageous to the buyer. If it costs $60 to cut and market 1,000 board feet of dimension stock of all sizes, the producer must get a return of at least $60. If the sizes in demand are such that they enable disposal

of only 750 board feet out of each 1,000 produced, the sale price must be $60 for the 750 feet or at the rate of $80 per thousand board feet. Hence the consumer whose cutting requirements are such that he can use a fairly wide range of sizes should be able to get a considerably lower unit price than a user who confines his purchaser to a few special large sizes.

### UNIT MARKETING

Marketing dimension stock in the form of units is a practice which has several commendable features. For instance, the pieces going into a sled, coaster wagon box, or similar type of product are cut to size at the mill and are sent in sets or units to the finishing and assembly plants. Prices are established per unit instead of per thousand board feet. Such a method of marketing necessitates a plant equipped to manufacture to a finer degree than is now customary in the average small dimension-stock mill.

### SUMMARY

Dimension stock from northern hardwoods, although made chiefly from low-grade logs and mill waste, is a product that requires close supervision and constant attention to details.

Ordinarily dimension stock is cut from mill waste with standard sawmill equipment; however, many mills that are operated either as auxiliaries to lumber mills or as small independent mills have special equipment for cutting dimension stock from small timber, much of which is necessarily cut even under selective-logging practice. Cutting dimension stock from short bolts is especially adapted to small operations with light equipment. Electric power is well adapted to small mills, especially if there is a good outlet for fuel wood.

The practice of crosscutting logs before head sawing them is economical in that it eliminates crooks, simplifies log handling on the carriage, and reduces waste at the head saw. Material is also saved if flitches are crosscut before they are ripped. Improper allowance for shrinkage and inaccurate sawing as a result of poor machinery and poor workmanship are chiefly responsible for dimension stock that is offsize.

With a fair quality of logs 8 to 11 inches in diameter, inclusive, the average difference at the mills studied between the cost of production of dimension stock and the selling price was about $13 per thousand board feet. The cost of production decreased with increase in size of logs. The size and value of stock increased with increase in size of log. The profit in logs from small trees should be considered in the light of the greater profit in them if allowed to grow to large size. The tendency toward greater refinement and diversification of product manufactured at the sawmill holds possibilities for improved and more conservative cutting practices in the woods and points to the practicability of cutting even the larger and better logs of certain species directly into dimension stock instead of into lumber.

Dimension stock at the mills studied was produced from bolts for $47.29, from small logs for $41.53, and from mill waste for

$26.73 per thousand board feet. The difference is in a large measure one of cost of raw material. Mill waste has low value, logs and bolts have comparatively high value. However, on account of its larger size, the sales value of stock from small logs and bolts is greater than from mill waste.

Under favorable market conditions it is sometimes profitable to supplement the exclusive manufacturing of dimension stock with several other products. Such products may be railway ties, mine caps, fuel wood, boxing and crating material, or standard grades of lumber. This variation of products permits the use of the better parts of the logs for dimension stock and the poorer parts for the other products, and consequently a poorer grade of logs can be utilized.

The bulk of dimension stock now cut from mill waste is small squares that average about 1.2 inches in cross section by 36 inches long. At present, little advantage is taken of the opportunity to cut flat stock. Improvements in machines and manufacturing methods are resulting in better stock cut at less cost than formerly. Carefully worked mill waste will yield dimension stock equal in volume to about 4 per cent of the net scale of the logs cut on the head saw. One cord of paper birch with bolts averaging 9.8 inches in diameter will yield about 330 board feet of dimension-stock squares. On a cubic-foot basis, logs 8 inches in diameter will yield about 35 per cent of their volume in dimension stock; 11-inch logs will yield about 42 per cent.

Although standard specifications are available for some classes of stock they are seldom used, and dimension-stock inpection is generally too lax. There also is considerable room for improvement in sorting and bundling operations. The relative merits of the various sizes and types of bundling, binding material, and methods of bundling are insufficiently known. Putting stickers in bundles does not appear to be entirely practical.

Dimension-stock seasoning, as well as methods of piling, is in experimental stages. Little kiln-drying is done at the mills. Success in kiln-drying is largely a matter of choice of species and sizes that lend themselves readily to kiln-drying. Losses in air-drying are not excessive, although careful methods are essential. Drying stock in bundles is generally unsatisfactory for it results in lack of uniformity in drying together with excessive molding and staining. End coating is an effective means of reducing checking of stock in drying.

Although good cost-finding systems are essential in determining the cheapest operating methods and proper selling prices, they are rarely found in dimension-stock mills.

Marketing under present conditions is a problem common to all dimension-stock producers. It would be simplified by standardization of cutting sizes, more stable prices, and a strong organization of producers.

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